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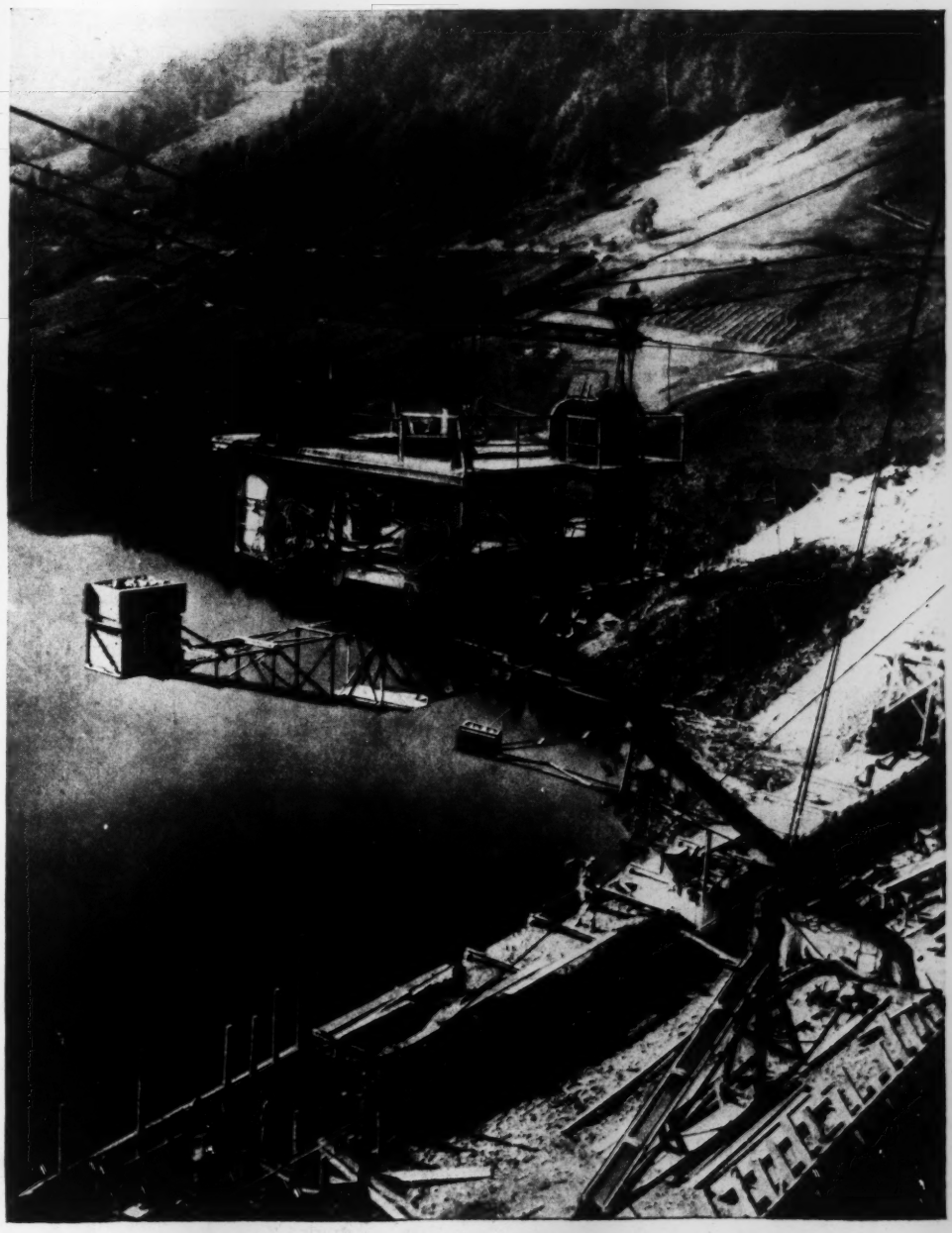

4-cu. yd. Concrete Hopper on Aerial Cableway, Waeggital Power Development

Swiss Electric Plan Increases Power by Pumping

Pennsylvania Railroad Builds New Freight Cut-off

Building Double-Deck Highway in a Rock Cut

Working Tests Show Direct Oxidation Not Suitable for Sewage of Allentown, Pa.

Building New York's Third Subway System - V

Does the New York State Barge Canal Pay?

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Editor

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Protecting the Public

TEMPORARY structures on and around construction jobs and especially those to be used by the general public should be designed and erected with a maximum of care. Too many of them are falling down. When a trestle-sidewalk structure without warning falls into a foundation excavation injuring several passers-by, when a half block of street decking over a subway operation completely collapses, even though commendable policing prevented injury to anyone, or when a temporary detour bridge is crushed beneath a truck it is not enough to say that some such failures are inevitable and must be charged to a so-called natural construction hazard. Nor can any satisfaction or redress be gained by blaming the public for sometimes taking unnecessary chances. To the average man any assembly of lumber around a construction job open to the public is permanent. Should this assembly be a bridge, a trestle-sidewalk or a decked street his thinking reactions toward any danger of collapse are probably nil. Likewise he will stand directly beneath a bundle of steel members as they are being hoisted 10 to 20 stories above the street while under the same conditions contractors' workmen will be found at a safe distance and with heads up. This contrasted attitude illustrates the crux of the whole matter of providing protection for the public—temporary structures entirely adequate for use by workmen on the job are dangerous when accessible to the layman. Most workmen have a construction sense while the man of the street has none. It is therefore incumbent upon the contractor to minimize the injury hazards around his job by providing safer temporary structures for the public's use.

Hydraulic Fill Shrinkage

SHRINKAGE of hydraulic fill comes up seldom as a major question either in planning embankment height or in computing estimates for progress payments to the contractor. Ordinarily it has been held by the practical constructor to be a negligible item in the volume of work. Is it? The question has been raised on a hydraulic fill operation in Florida where it is desired to take fill cross-sections to check cut measurements. Location of the fill on a mud flat, with a hard bottom, complicated the problem by bringing in the factor of subsidence by compression or squeezing out of the mud. The sectioning showed a subsidence of about 25 per cent. Obviously, little of this was due to true shrinkage but how much might the shrinkage be? A considerable search of books and articles on hydraulic fill reveals a surprisingly small volume of evidence. In building a hydraulic-fill dam in Porto Rico some ten years ago careful measurements showed a shrinkage in vertical height of about 0.5 per cent. Measurements made on two of the dams for the Miami Conservancy District gave for one a shrinkage of about 0.33 per cent and for the other 0.5 per cent. These are all the definite measurements of which we have been able to find a record. If any of our readers have further figures it would be helpful to make them known.

Thrift and the Gasoline Tax

NEW JERSEY is one of the four or five states left which do not impose a gasoline tax and naturally a campaign is now on there to bring it into line with the rest of the country. In commenting on the proposed tax a New Jersey newspaper, opposed to the tax, to flout the argument that a gasoline tax is desirable because it charges the foreign driver for the use of the road, draws a picture of the state boundary lined with gas stations in the tax-free neighbor states, with lines of cross state tourists stopping to fill their tanks before entering this tax burdened area. This is rather far fetched. The biggest automobile carries only 15 gallons of gas. Even assuming that it arrived at the state line empty, the saving in the tax free state is only 30 or 40 cents, and of course the average saving would be less than half that. It is a pretty picture of a thrifty nation, this conscious effort to save 10 cents when touring, but it is hardly in accord with facts. Besides, New York is New Jersey's only tax-free neighbor, and who knows when she too will pull into line.

Open to Question

SOME State Health Departments use a method to compel the installation of sewage-works by municipalities that is open to question. They refuse to grant permits for sewer extensions until their orders to build sewage-works have been obeyed. This seems logical enough as a mere penal measure or as a means of protecting cities or property owners below sewer outfalls, but looked at broadly as a matter of the greatest good to the greatest number is the policy sound? The abolition of cesspools and privies, in order to get human wastes away from houses, has a far more vital relation to public health, as a rule, than does the final disposal of sewage. In most cases the chief effect of sewage treatment is nuisance prevention rather than health protection. There is a remedy at law for those who suffer from nuisance; and there is or should be even more sure and speedy remedy at law where menace to health can be proven. These facts might well be taken into account before state health authorities deny householders sewage-removal facilities in order to compel a city to build sewage-works. Such a means of compulsion looks like a confession of weakness and raises questions as to whether some state health authorities have a clear conception of either their functions or the way they should be exercised. Moreover, in the past if it is not still true, many state health departments concentrated on sewage disposal and neglected far more vital health measures, particularly means to compel municipalities to supply pure water. To make the mat-

ter worse, every one who is well posted knows that a large percentage of the sewage-works built are so poorly operated as to be of little benefit to anyone, although running up large capital outlay and operating expenses. To cite these facts is not to argue against sewage-works but merely to call for a re-consideration of the whole matter from the viewpoint of relative health values and real efficiency in state health administration.

Motor Vehicle Accidents

FEW states excel Connecticut in the consideration given to motor vehicle hazards. It has an excellent statistical bureau for recording and classifying accidents, its traffic regulations are comprehensive, its disciplinary measures are particularly forceful and its educational methods are in advance of general practice. Yet in reviewing the accident records of the last two years with a similar review for 1923 for comparison, R. S. Kirby of the department of civil engineering of Yale University using the state statistics and sponsored by the state commissioner of motor vehicles, sees scant improvement. The opening sentence of Mr. Kirby's report is: "The motor vehicle accident situation in Connecticut does not yet show many signs of improvement." And almost its final remark is: "There have been but few encouraging features to record." This is a most gloomy conclusion. There are indeed agencies who dispute its justice and present figures in proof. But Connecticut's figures have, to those who know how most motor vehicle accident records are compiled, a rigid precision which makes them difficult to set aside. There is cheer in believing that the accident rate due to motor vehicles is being materially reduced. With the Connecticut records before us, however, we cannot confidently do so.

Good Construction

A FAMOUS old engineering structure justified the pride of its builders when, in building New York's third subway system, the necessity came to uproot the elevated column footings in Eighth Ave. north of 110th St. Except the famous high curve at 110th St., of the 6th Ave. line, here was the highest structure of the old elevated railways of New York. Not only was the structure high above ground but for various reasons stated in the article in this issue by Lazarus White, the foundations went deep below the surface. Then, half a century ago, concrete was not a common material and portland cement imported from Europe was a material to be used frugally, so footings of brick masonry in portland cement mortar were constructed for these bold elevated structures for steam railways. Some of these brick piers were 30 ft. high above the footing course of rough concrete probably of natural cement. It is the evidence of Mr. White, an engineer experienced beyond most in New York city foundations, that the elevated railway builders took their masonry well down to stable foundation beds, and that the brickwork after 50 years was in excellent condition. Indeed, noting how this brickwork was cut through without shattering, as shown by the sketches and views from photographs given in Mr. White's article, his written word is hardly necessary as evidence of quality. There is no marvel of course in good foundation work 50 years old, but it is not too often that those who build after say well-done of what was built before.

Barge Canal Bookeeping

ON ANOTHER page of this issue Maurice W. Williams, an engineer who for many years was connected with the New York State Barge Canal, presents an argument in justification for the economic possibilities of that much criticised waterway. His claim is that when or if the savings effected by the carrying of freight on the Barge Canal become greater than the actual cost of the waterway to the state, then the canal becomes justified as a public enterprise. No attempt is made to prove that the people of the state who pay for the canal participate in all of the savings which accrue to the shippers. The argument is general; that is, that any saving in transportation reacts to the good of the whole commonwealth and the possibility of some of that saving running over into adjoining states which do not pay for the construction which brought the saving about is not considered.

Mr. Williams presents credible figures. He has investigated what a number of shippers have saved by their use of the canal over what it would have cost to have shipped by rail, and has compared these savings with the savings on the other waterways, as a result of which he has arrived at a figure of $1.15 per ton saved for every ton of freight which goes over the canal regardless of the distance it is to be shipped. He then analyzes the amount of shipment over the canal and finds that this has been increasing, in accordance with a fairly common increase on other waterways, at the rate of 10 to 11 per cent a year. Using 10 per cent as an average increase he arrives at a certain saving each year until, in 1948, on that basis, the canal will have reached its capacity of 20,000,000 tons annually, beyond which time the annual savings will be, of course, only on that amount.

He then goes back to the cost of the canal, and he itemizes annual costs made up of, first, the amortization and interest charges which the state is paying annually, around $6,000,000 a year; the maintenance and operating costs, around $3,000,000 a year; and the permanent betterment and claims cost, around $1,000,000 a year. This total of nearly $10,000,000 a year is taken as the annual cost to the state of the Barge Canal. Then he says: At that time when the total saving to the shippers equals the total annual cost to the state, both as figured above, that year the canal begins to be a paying proposition. On this basis he claims that in 1939 the canal will commence to pay and that by the time it has reached its capacity, in 1948, it will begin to make $13,000,000 to $14,000,000 a year, and in 1960, when it is fully amortized, it will be making $20,000,000 a year.

There will be those who may question the propriety of assuming that this barge canal will continue to be in use as long ahead as 1960, who believe that obsolescence is a much greater wrecker of such public works than is depreciation or neglect. There will be those who question the assumption that because a certain shipper in the State of New York saves a certain amount of money that the State of New York itself is justified in spending that much money to effect the saving. There is further the fallacy that money a shipper saves is community benefit whereas money a railroad takes in is private profit; in other words a true computation of saving to the community should establish the difference between real costs of the two methods of transportation,

not between cost on the one hand and market price on the other.

But all of these questions are subordinated by the major criticism of the method, which is that it fails to consider the tremendous sums of money which the state has paid out in operating and maintenance costs and in interest charges and which have been piling up for all of these years and will for many years continue to pile up as deficits in a proper bookkeeping.

Let us look at the canal as we would at a private business enterprise, using Mr. Williams' own theory of costs and savings. In 1905, we will say, the state of New York had no barge canal; in 1955 it will have a canal carrying 20,000,000 tons (taking the optimistic forecast Mr. Williams presents) which soon thereafter will represent a clear profit of $20,000,000 a year. Between 1905 and 1955 there lie 50 years during which the state will have paid out a certain amount of money and during which the shippers will have saved a certain amount over what it would have cost them to have shipped by other means had the canal not been available. What, then, will be the comparison at the end of these 50 years between the amount paid out by the state and the amount saved by the shippers?

We shall use only rough figures throughout. The State of New York has spent for construction on the Barge Canal around $170,000,000. It has issued $152,000,000 of bonds at an average rate of 4 per cent, directly chargeable to the canal; these bonds mature at various times from 1942 to 1967 but for the purpose of this rough comparison it is sufficient to assume them all maturing in 1955. The other $18,000,000 came from some other source, which is not given in the reports now available. But however the money was raised, the state will have to pay to its creditors in 50 years time that $170,000,000. It may, by setting up a 3 per cent sinking fund, amortize that amount by paying out in the whole 50 years around $75,000,000, but in addition for the entire 50 years it will be paying around 4 per cent interest, which will total about $340,000,000. For the 36 years of this 50 that the canal will be in operation it will, on Mr. Williams' own figures, have an annual maintenance and operating charge of about $3,000,000, say $108,000,000, and a permanent annual improvement fund of $1,000,000, say $36,000,000. This means that 50 years after it started, that is in 1955, the Barge Canal will have cost the state a total of around $559,000,000, minus such interest and premiums as accrued during the construction period when there was a greater sum in hand from bonds sold than was required for construction payment. In 1924 Governor Smith said that amount was $25,000,000. Call it $29,000,000, and the total cost of the canal to the state in 1955 will be about $530,000,000.

Now, what will the shippers (and the state, according to Mr. Williams) be saved in this period? From 1919 to 1924 there were nearly 10,000,000 tons shipped on the canal, which, at the $1.15 a ton estimated saving, is $11,000,000. From 1925 to 1947, with an annual 10 per cent increase figured by Mr. Williams, there will be about $215,000,000 saved, and from 1948 to 1955, when the canal will be operating at capacity, the saving would be about $184,000,000, a grand total of 410,000,000.

It would take another six to ten years, therefore, before, the total savings, as figured by Mr. Williams, would equal the total cost; that is sometime between 1960 and 1965, sixty years after the work was started, paper profits would begin to accrue. That is the proper time to consider the canal a paying proposition, and not in 1938, when the annual credit passes an annual charge based on a sum which neglects accrued deficits.

This is not the popular method of figuring the cost of public works. Money spent for interest on funds long expended does not figure very much in public accounting. But so long as a bookkeeping justification is being attempted for the New York State Barge Canal, it is just as well to consider some of the plain arithmetic involved. Deficits in government may be met by a stroke of a fountain pen, but they should not be forgotten when economic justification is being sought. And has the history of any 60 years in the past been such that we are justified in assuming that we can plan 60 years ahead in the utilization of any transportation agency?

Direct Oxidation Again

ANOTHER of the many experimental and working-scale plants built to treat sewage by electrolysis seems destined to come to an early end. The lure of electrical treatment captivated Webster in England forty years ago and has since taken possession of a half dozen inventor-promoters, chiefly Americans. Of ten straight electrolytic plants built with the good money of American cities not one is in use today. Electrolytic treatment would have been a dead issue years ago had not one of its more recent promoters combined it with excess-lime treatment. The combination has made little headway notwithstanding vigorous promotion in many cities and states. Today, the doomed plant at Allentown, a small one at Phillipsburg, N. J., and one of considerable size at Winston-Salem, N. C., stand as the tangible working results of forty years of effort in the electrolytic treatment of sewage—and water also, for that has been included in the projects of some of the promoters.

To the considerable number of articles and letters on the electrolytic and lime-electrolytic or direct-oxidation plants and projects published in this journal and in the two journals united to form it in 1917 there is added, on p. 422 of this issue, a considerable part of a report on a seven-day test of the Allentown plant, by Metcalf & Eddy.

The report contains brief running comments on the various elements of the test, but no summary of net results, except this cogent sentence among the general conclusions: "The sewage treatment plant now in operation at Allentown is not of a type suitable for adoption for the treatment of the sewage of the whole city due to the fact that the purification effected is inadequate, the operating charges are high and the quantity of sludge produced is excessive." In its general application, this conclusion is in line with practically all independent expert opinion on the process, uttered publicly or privately, during the dozen years since it has been under discussion. Furthermore, the report contains strong evidence that lime rather than electrolysis is the main factor in the combination, and it is lime treatment, with its heavy sludge production, that engineers and cities have been cutting free from for the last two or three decades.

Swiss Electric Plant Increases Primary Power by Pumping

On Waeggital Power Development in Switzerland Excess Water Power During Spring Flood Used to Pump Water Into High Storage Reservoir for Fall and Winter Use

By P. E. Gisiger
Structural Engineer, Pennsylvania Water & Power Co., Baltimore, Md.

SWITZERLAND in 1924 consumed 725 kw.-hr. of electric energy per capita (U. S. 1925, 600 per capita) and is, in this respect, as far as the writer's knowledge goes, leading any other country. To arrive at this high utilization of electricity and to make the best possible use of the country's vast resources of hydro-electric power, Swiss engineers have to overcome many

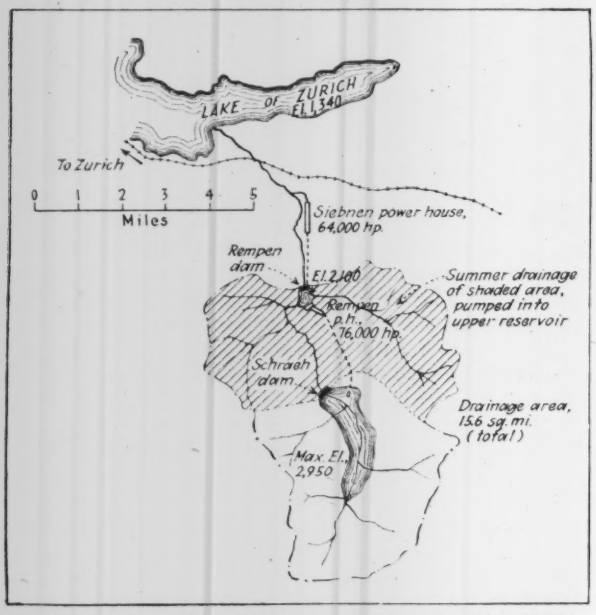


FIG. 1—GENERAL PLAN OF THE WAEGGITAL POWER DEVELOPMENT

handicaps, chief of which is the uneven distribution of river flow over the year.

The annual rainfall amounts to about the same figure as the average in the northeastern United States. But of the total precipitation a large amount is kept back as snow on the higher reaches of the Alps. Part of this goes to form the numerous glaciers and as such constitutes storage and equalizes river flow; but the other part swells the rivers in spring and all of it is kept back during winter, with the result that all Swiss rivers have a period of high flow in May and June, and very low flow from October to March. Fig. 2 shows the average monthly flow of the river dealt with more specifically in this article, for a typical year; the general character of the hydrograph is the same for all water-courses of Switzerland. Thus, the period of low flow falls together with the period of high demand for energy and all hydraulic engineering in Switzerland has to contend with this fact.

Prior to 1914 little progress had been made to improve the natural conditions with accumulating basins. The general trend had been to build low-head run-of-river plants and to provide steam or Diesel-engine auxiliaries, so that at that time the winter supply of peak power was dependent, to a large degree, upon the importation of fuel. With the war fuel imports became uncertain and at once the unbalanced condition of the country's water power supply was felt. Fuel-consuming stand-by and peak load plants could not be operated at a time when the same lack of fuel caused an enormous increase in the demand of electricity for heating and cooking purposes and industries were expanding to supply the needs of the belligerent neighbor countries.

The resulting consequences were felt especially hard in the city of Zurich and the surrounding industrial territory which was served principally by a medium-head plant. In 1917 a high-head storage plant of 9,000 kw. capacity was added, but even in the same year the city had to buy power from outside concerns to make up its requirements of about 130,000,000 kw.-hr., and had to look for new sources of supply.

The country around Zurich, industrialized to a high degree, is served by the Swiss North Eastern Power Co. This utility was comparatively well off, having demonstrated at an early time the advantages of coupling a low-head run-of-river plant with a high-head

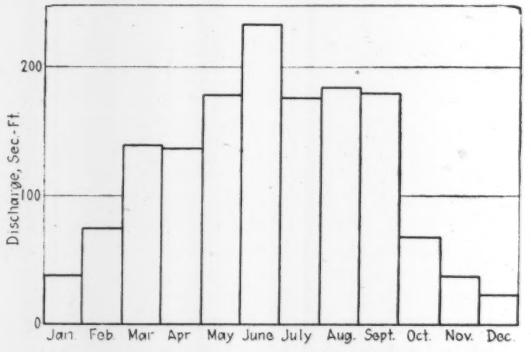


FIG. 2—AVERAGE MONTHLY DISCHARGE OF WAEGGITAL CREEK FOR A TYPICAL YEAR

storage plant. The addition of a 40,000 kva. low-head plant in 1918 made it necessary, however, to balance the system with a new storage development for winter requirements. The city of Zurich as well as the power company had made preliminary investigations about power and storage possibilities in the valley of the Waeggital Creek, a mountain stream with a drainage area of 15.6 sq. miles, emptying into the Lake of Zurich (Fig. 1). It was natural, therefore, that when both producers felt the need for more power, they should develop this source jointly. A new company was formed in which the city of Zurich and the S. N. E. P. Co. took a half interest each. Work was begun in March, 1922, and in December, 1924, current could be supplied to the systems of the parent organizations.

The nature of the development and its water supply are such that a careful determination of the required

FIG. 3—SCHRAEH DAM SITE AT BEGINNING OF WORK
View looking northeast.

FIG. 4—SCHRAEH DAM DURING CONSTRUCTION
View looking southwest; mixer plant and concreting tower at right.

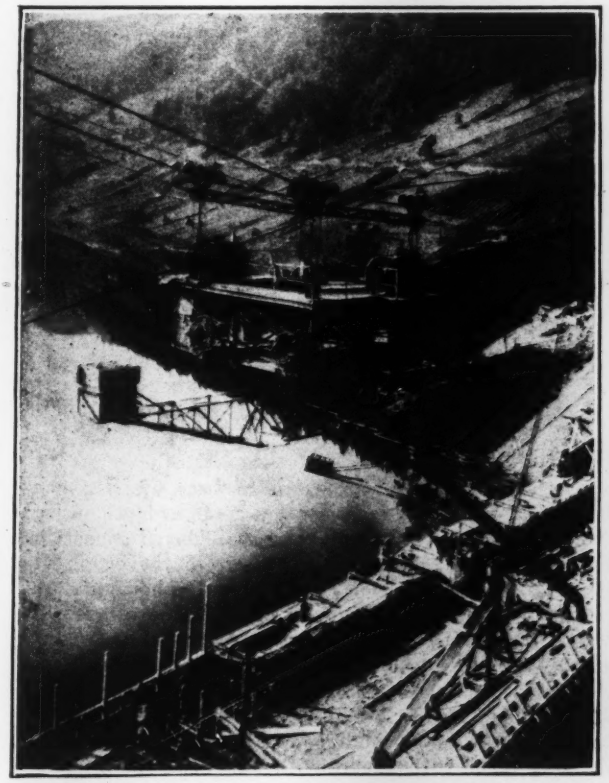


FIG. 5—SCHRAEH DAM, 4-CU.YD. HOPPER OF AERIAL CABLEWAY DISTRIBUTING CONCRETE

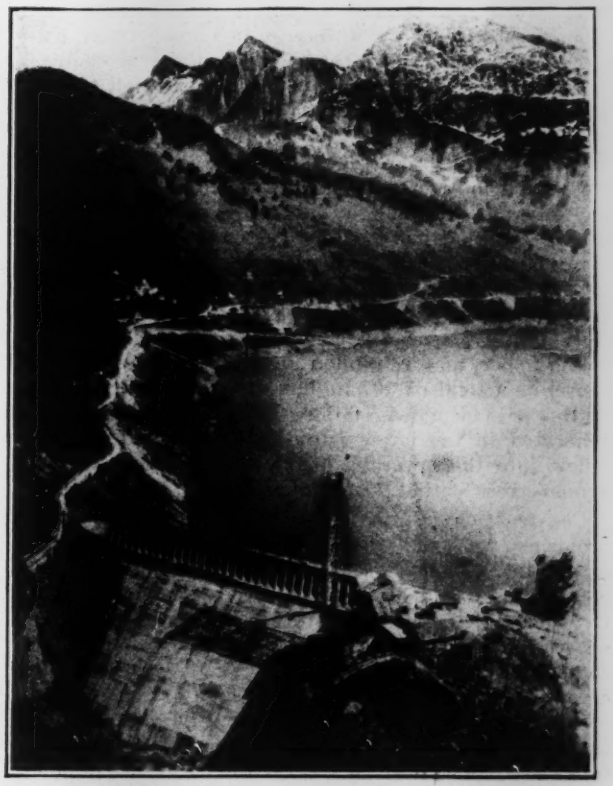


FIG. 6—SCHRAEH DAM NEARLY COMPLETED
End tower of aerial cableway at extreme right.

storage capacity was essential. It was found that in order to make complete use of the whole drainage area and to equalize yearly fluctuations, the useful storage capacity had to be about 9 per cent higher than the average yearly discharge, or five billion cubic feet.

At first development of the available gross head of 1,485 ft. in one stage was considered, but detailed estimates proved a two-stage development to be more economical (Fig. 7). The topographical features prevented the construction of the main dam at a point where the drainage of the whole area could be caught. This fact made the designers adopt the plan of pumping water from a lower altitude into the main reservoir

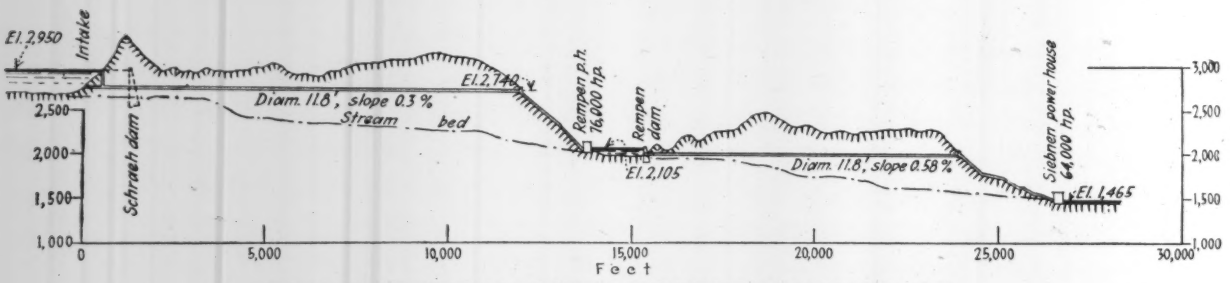


FIG. 7—LONGITUDINAL PROFILE OF WAEGGITAL DEVELOPMENT

at times of high flow, and releasing it from there at times of low flow. The over-all efficiency of such a scheme is of course low; but in this instance, it proved a good investment, as the pumps are run at off-peak times during the high flow period in spring with power from the interconnected run-of-river plants, which formerly had to be wasted over the spillways. In other words, secondary power is transformed into primary power, and the difference in value between both classes of current more than makes up for mechanical losses incurred in the process. It is estimated that 32 million kw.-hr. will be used annually for pumping.

The plans for storage and output were then fixed as follows. The average yearly discharge of the drainage area is 4.5 billion cu.ft. Of this, 3.5 billion cu.ft. is the natural yearly inflow into the main upper storage basin; 1 billion cu.ft. is the summer inflow into the lower basin, which is pumped into the upper basin in the time between April 1 and Oct. 31. The whole 4.5 billion cu.ft. are to be released in the time between Nov. 1 and March 31, generating 60 million kw.-hr. in the upper, and 47 million kw-hr. in the lower power house, or a total of 107 million kw.-hr. primary power. To this is to be added 5 million kw.-hr. secondary power, generated in the lower power house from the winter inflow into the lower basin, making the total average annual gross output 112 million kw.-hr.

Construction Details—One of the main construction problems was the transportation of materials and equipment. To lay track to the upper dam and power house sites would have been very expensive. Instead, it was decided to ship everything by truck from the nearest railroad station, which is about five miles horizontal distance from the largest single operation, the Schraeh dam. A considerable mileage of roads had to be built or improved, and a force kept busy to maintain them during construction. In the record month 9,000 tons were hauled over an average distances of five miles, the heaviest single load being 40 tons on a specially built truck.

The main structure of the whole development is the Schraeh dam (Fig. 8). It is a massive gravity wall of triangular cross-section, 220 ft. high above the stream bed and 362 ft. high above the deepest point of the foundation. Its length on the top is 550 ft., the volume of concrete 305,000 cu.yd. Up to a certain elevation the concrete was poured from a tower with chutes, but in the upper part it was poured from an aerial cableway shown in Fig. 5. The concreting plant included four 1½-cu.yd. mixers, each served by a battery of four bins for graded aggregate and one bin for cement. The power company maintained an elaborate testing outfit at the site and the utmost care was taken to obtain a concrete of maximum strength and density. The largest day's pour was 2,000 cu.yd. Horizontal and vertical expansion joints subdivide the dam into a number of separate blocks. The dam so far has proven to be perfectly tight.

An interesting feature about the foundation of the Schraeh dam is that the deepest portion of it was not poured first. At the dam site the V-shaped notch cut

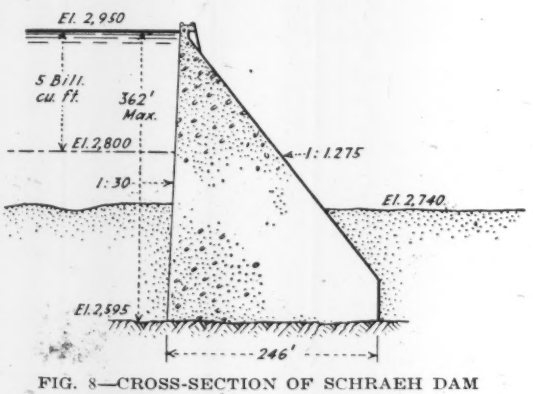


FIG. 8—CROSS-SECTION OF SCHRAEH DAM

by the river into the rock extended down 140 ft. below the actual river bed. Excavation to this depth proved to be a slow process and would have delayed concreting for several months. Pouring of concrete, therefore, was started before excavation had reached the bottom of the notch and carried up high enough for the concrete to support itself by arch action between the two abutments; then excavation below this layer of concrete was continued, material being removed through several vertical shafts which had been left open. When the bottom of the notch finally was reached, the whole cavity was filled with concrete through the same shafts. This operation was described in *Engineering News-Record* of Aug. 28, 1924, p. 345.

During construction of the dam, the Waeggital Creek was by-passed through a diversion tunnel. This tunnel is controlled by two butterfly valves, through which the lake can be emptied whenever this should become desirable. The intake for the power house is located away from the dam and formed by a pressure tunnel opening into the lake 180 ft. below the normal water level. The opening can be closed by means of a roller gate 13 x 20 ft., the seat of which is formed by a frame of polished granite, against which a rubber sealing strip attached to the gate is pressed when the gate at closing position is released from its rollers. When opening, the gate travels on guides following the natural slope of the reservoir bottom up to an operating chamber. When the gate is lifted, a screen traveling on the same guides is lowered in its place. Vertically

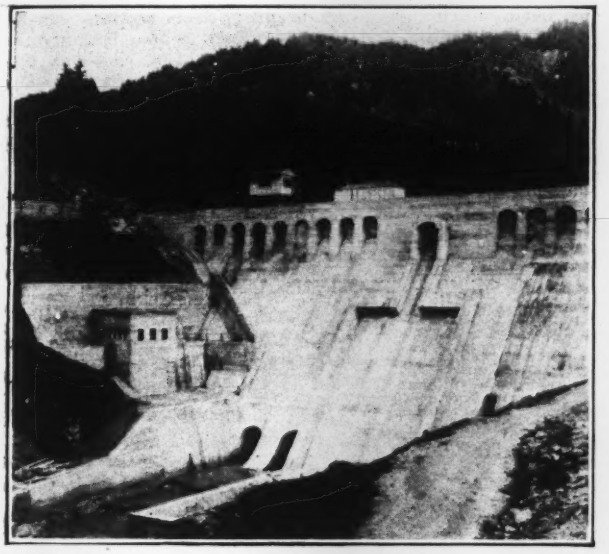


FIG. 9—REMPEN DAM SYPHON SPILLWAYS IN CENTRAL PORTION

under the operating chamber and 500 ft. back of the opening, the tunnel can be closed with a butterfly valve operated by oil pressure.

From the intake the tunnel leads with a slope of 0.3 per cent over a distance of 12,000 ft. to the surge chamber, from which two penstocks of 8 ft. diam. in the upper portion and 6 ft. 10 in. diam. in the lower portion lead to the power house. The bottom of the surge chamber is at elevation 2,730 ft. and tail water at elevation 2,105 ft. The total weight of penstocks is 1,970 tons and the maximal slope is 40 degrees. At the entrance into the power house, each penstock is split in two and each branch controlled by a spherical valve.

The characteristics of the Francis single runner vertical shaft turbines are: net head 758 ft., flow 256 sec.-ft., 19,000 hp., 500 r.p.m., runner diameter 71 in., runner of cast bronze. The generator characteristics are: 16,500 kva., power factor 0.8, 8,800 volts, 50 cycles.

Besides the four generating units, the power house contains four pumping units, consisting each of a 5,100 hp., 50 cycle, 750 r.p.m. vertical shaft motor, directly connected to a rotary pump of 45 sec.-ft. capacity against a head of 800 ft. These pumps deliver the drainage which collects below the Rempen dam through the penstocks into the main reservoir at times when there is secondary power available from interconnected low-head plants. This condition exists regularly in the spring and summer, with Waeggital plants shut down.

In normal operation, the water discharged from the Rempen power house is caught by a second dam, forming a basin of 17,000,000 cu.ft. capacity. This dam is again of gravity section and 92 ft. high. Its basin can be emptied through two bottom outlets controlled by sluice gates. Besides this, excess water is taken care of by two syphon spillways and an automatic crest gate. The tunnel intake in the east abutment is controlled by a butterfly valve of 11 ft. diameter. The tunnel has the same cross-section as the one for the upper development and measures 8,500 ft. from intake to surge chamber. A ravine which cuts deep into the mountain side had to be spanned with an aqueduct. In the surge chamber the water enters two steel penstocks and falls from elevation 2,000 ft. to a tail-water elevation of 1,455 ft.

The Siebnen power house contains again four units of Francis single runner vertical shaft water wheels, 500 r.p.m., 266 sec.-ft., 16,000 hp., connected to 3-phase, 50-cycle generators of 16,500 kva. capacity, at power factor 0.68. Adjoining the power house is the transformer and switch building, which forms the point of distribution for the upper as well as the lower development and ties together the transmission systems of the city of Zurich and the Swiss North Eastern Power Co. To Zurich, power goes over four circuits of 50,000 volts. The power company has two outgoing circuits of 100,000 volts and five circuits of 50,000 volts. Two other 100,000 volt circuits form a tie with transmission systems of Central and Western Switzerland.

The costs for the entire development, exclusive of transmission lines, was estimated in 1920 at $16,200,000. The annual report of the Waeggital Power Co. for 1925 says, that with the development practically completed in the fall of 1925, the cost to date was $14,800,000, the reduction being due to lower prices for labor and material at the time of construction. This is equivalent to 1.2 cents per kw.-hr. Considering the cost, it has to be borne in mind that the 112 million kw.-hr. generated in this development convert into primary power an equal, or larger, amount of kilowatt-hours generated in the interconnected run-of-river plants, which heretofore was secondary power.

Of the total estimated cost, 9.4 per cent was for land and water-rights and preliminary work, 20.3 per cent for the Schraeh dam, 3.1 per cent for the Rempen dam, 16.4 per cent for intakes, tunnels and surge chambers, 9.6 per cent for penstocks, 6.8 per cent for buildings, 21.3 per cent for mechanical and electrical equipment, and 13.1 per cent for engineering and interest.

The development was designed by the joint engineering staffs of the Swiss North Eastern Power Co. and the city of Zurich's Power and Light Service, under the supervision of F. Gugler, chief engineer of the S. N. E. P. Co., who also was in charge of construction. Walter Trueb of the Zurich Power and Light Service, was responsible for mechanical and electrical installations. All work was done by contract and the various construction units split up among several firms. The writer visited the development in April, 1925, and is indebted for a large part of these data and most of the pictures to E. Schnitter, assistant superintendent with H. Hatt-Haller Co., contractors for the Schraeh dam.

Five-Purpose Water Treatment Plant at Tampa, Fla.

Besides Filtration and Chlorination Water Is Decolorized, Softened, and Recarbonated to Prevent Corrosion

A SOFTENING, decolorizing, recarbonating, filtering and chlorinating plant was recently installed by the Tampa Water District, Florida. It has a capacity of 12 to 15 m.g.d. and makes it possible to reduce the draft on the old well system to 6 m.g.d., so as to avoid getting "excessively hard or saline water," says N. S. Hill, Jr., consulting engineer for the new supply, in a paper in the *Journal* of the New England Water Works Association for June. The new river supply is of good quality, but during the rainy season swamp overflows produce a highly colored soft water, while in the dry season, with the yield chiefly from springs, the color is low and the hardness is high. Contrasts in the water from the rainy to the dry season, in parts per million, are: Color, 200 and 25; total hardness, 25 and 200; alkalinity, 24 and 140; sulphate hardness, 1 and 60; turbidity, 1 and 0. Practically two treatment plants in one are required to meet the two widely different kinds of water, and intermediate gradations. The case for decolorizing, softening and recarbonization is thus stated by Mr. Hill:

Decolorizing—The most important treatment is that for color removal. Aluminum sulphate and sulphurous acid are used to accomplish this. Heretofore aluminum sulphate alone generally has been used for the purpose. However, this chemical is expensive and when color ranging from 100 to 200 p.p.m. is to be combated, the cost is almost prohibitive. By the addition of sulphurous acid, the alkalinity may be neutralized and the hydrogen-ion concentration raised to a point where the most complete precipitation of the aluminum sulphate as aluminum hydroxide takes place. As a result, a much smaller amount of aluminum sulphate is required for the complete removal of color than when aluminum sulphate is used alone. Lime or soda ash, added after filtration, again lowers the hydrogen-ion concentration and cuts down the amount of free carbon dioxide in the water to a point where the water can be distributed safely without danger of corroding the distribution system.

Softening—During a portion of the year softening is required in addition to the decolorizing treatment. The flexibility provided in the design of the sedimentation basins makes it possible to change readily from a decolorizing to a decolorizing-and-softening plant. By the use of hydrated lime the carbonate hardness is thrown down. If, in addition, the water has a sulphate hardness, soda ash is added to reduce it. The water then passes to decolorizing tanks and basins where aluminum sulphate is added. The aluminum sulphate lowers the causticity due to the addition of the lime, and removes the color. The water then passes to a carbonating chamber.

Recarbonization—It is believed that in recarbonization has been found the solution of one of the most perplexing problems in modern water purification. The demand for soft water has reached such proportions that in cannot be ignored by those responsible for the design of present-day purification systems. This has been recognized in the Tampa plant where, by the introduction of recarbonization, the evils of the usual softening plant have been avoided. Recarbonization eliminates the re-precipitation of calcium carbonate in filter underdrains, distribution system and meters, and the so-called sand growth, and gives a more palatable water. The amount of carbon dioxide introduced can be regulated accurately by the chemist in charge, so that the water, as delivered to the consumer, has the predetermined content necessary to give the most satisfactory water.

Besides a baffled soda ash mixing tank there are eight lime mixing and eight aluminum sulphate mixing tanks fed through brass orifices. The tanks are operated in series. Each lime and alum tank is provided with a motor-driven bronze impeller set in a 14-in. draft tube to provide agitation. There are two 1-m.g. lime settling basins and two 0.75-m.g. decoloring basins, giving 4- and 3-hr. detention periods at normal operating rates. These basins may be operated in series or in parallel. The sludge removal system is thus described:

Sludge Drainage System—Through the first half of each settling basin, a series of lateral drains, consisting of 6-in. vitrified bell-and-spigot pipe tees [38½ in. c. to c.], have been laid in the floor of the basin, with the branch of the tee pointed up and set flush with the finished floor. A 6-in. vitrified plug, with a 1-in. orifice, was placed in each bell. Sloping concrete ridges separate the rows of pipe. The underdrains are conencted up to the headers at the side of the basin which collect and discharge from sections consisting of five lines of underdrains. Each header is controlled by a gate valve and discharges into a 12-in. cast-iron pipe leading to the sewer. By opening the gate valve, the water in the basins is utilized to flush out the sludge which has been deposited over the bottom of the basin. The sludge drainage system may be back washed with water under moderate pressure so that if the sludge surrounding the drains becomes hard or caked it may be loosened. As a great portion of the sludge is deposited in the first half of the basins, it was not considered necessary to continue this construction through the second half. A 4-in. flushing line with hose nozzles has been provided for cleaning this portion of the basins.

Six Gauntt dry-feed chemical machines are provided, two each for lime, sulphate of alumina and soda ash. Two Shutte and Koerting burners with accessories, convert sulphur into carbon dioxide gas and thence into sulphurous acid, the latter being introduced into the chemical trough that receives the sulphate of alumina. Carbondale-New York equipment is used to produce carbon dioxide from coke for recarbonating the water. The gas is applied in a baffled carbonating chamber through a pipe grid on the floor. This grid, Mr. Hill believes, will give better results than the filtros plates heretofore used.

The eight concrete gravity filter tanks have as a strainer system half-round 6-in. cast-iron pipes, with lugs that raise them from the floor so as to give "practically a continuous horizontal orifice, ¼-in. wide, on both sides of the pipe." To release entrained air, 1-in. holes, 6 in. c. to c., are provided in the tops of these pipes. Cast-iron spacers separate the pipes to 12 in. c. to c.

All the chemical and filter apparatus was supplied by the American Water Softener Co., and the chlorinators by Wallace & Tiernan.

Tests of Calcium Chloride in Concrete

"Tests Show How Calcium Chloride Affects Concrete," by A. S. Levens, of the University of Minnesota, published in *Engineering News-Record* August 5, 1926, p. 214, had several typographical errors. The captions to Figs. 1 and 2 were interchanged, so that, in the charts showing the effect of calcium chloride on cement mortar, the time-strength caption was attached to the diagram showing only the strength change by percentages of calcium chloride, and vice versa. Also, in the author's original chart of shrinkage variation, given as Fig. 4, the contractions which read 0.0050, 0.0100, to 0.0500 should have read .00050, .00100, to .00500, that is, the decimal point should have preceded the first cipher, making the shrinkage one-tenth of that given.

Building Double-Decked Highway in Trap Rock Cut

Holland Tunnel Approach in New Jersey Requires Careful Blasting Because of Nearby Railroad Cut and Tunnel—Novel Concreting Plan

A ROCK CUT 60 ft. wide and 25 ft. deep is being excavated within 50 ft. of an existing railway tunnel and a parallel open cut, for the New Jersey highway outlet for the new vehicular tunnel from New York City. This cut is the emplacement for a double deck concrete road which, at the east side of the ridge west of Jersey City's water-front flat lands, connects with a steel viaduct descending to the tunnel portal. A general description of the structures was given in *Engineering News-Record*, April 30, 1925, p. 731, and methods of building the viaduct footings were described in *Engineering News-Record*, Sept. 2, 1926, p. 389. The sketch section, Fig. 1, shows the cut and the double-deck road structure and their location with respect to the existing tunnel and cut both carrying a very heavy railway traffic.

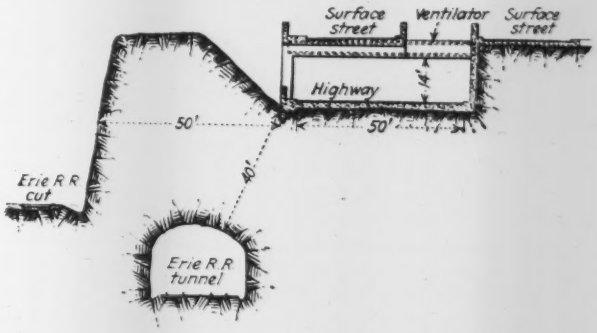


FIG. 1—SECTION SHOWING HIGHWAY IN RELATION TO RAILROAD TUNNEL AND CUT

FIG. 2—MAKING A 25-FT. ROCK CUT ON NEW JERSEY APPROACH ROAD TO HOLLAND TUNNEL
Blasting right side of cut first permitted left half to be blown out into cut with a minimum of jar to the railroad tunnel alongside.

Excavation Methods—There are 80,000 cu.yd. in the cut of which about 35,000 cu.yd. from the top are earth and loose rock. There are 45,000 cu.yd. of solid rock excavation in the hardest sort of Hudson River trap, vertically seamed as is usual with this rock but dense, tough and hard. To these difficulties in drilling and blasting were added the necessity of safeguarding the adjacent tunnel and cut and, to some extent, buildings along the top of the cut. Very narrow working spaces on the banks of the cut presented a problem. Along one bank too a relocated street railway had to be kept in service. The cut is 1,600 ft. long.

Blasting methods are interesting chiefly in connection with the hard rock excavation. The seams in the trap ledge ran diagonally across the cut in both directions intersecting at about the longitudinal axis. With the old cut and tunnel to the south, the north half of the cut is blasted first. This leaves a free space for blowing out the south half and so reduces shock to the old tunnel and cut. Withal light charges and careful drilling are required, since the traffic in the tunnel and adjacent cut is very heavy. The contractor notifies the railroad company each morning of the approximate times he wishes to shoot. The train dispatcher adjusts this time to train movements, and gives the contractor an exact time at which he may shoot. Following each shot, and before a train is allowed to go into the tunnel, representatives of the railroad and the contractor go through it on a motor car to inspect the walls for damage. A 40 per cent dynamite is used. The holes are drilled to a maximum depth of 12 ft., reducing $\frac{1}{8}$ in. with each 2-ft. length of steel.

Two 1¼-cu.yd. steam shovels, Fig. 2, load most of the material; a ¾-cu.yd. shovel is used for the smaller stone. This smaller machine also removed all of the 35,000 cu.yd. of common excavation. Approximately 45,000 cu.yd. of rock are being taken out. A crawler crane places the blasting mats and loads some of the trucks with one- and two-man stone. This is placed in skips by hand. The bulk of the stone, however, is loaded by the shovels. The truck entrance to the cut is a ramp at the east end. Since the cut is 60 ft. wide, there is no congestion. A maximum of 320 cu.yd. of rock has been removed in 8 hours. Excavation is to a pay line.

Drains depressed below the rock floor are placed on each side of the roadway, and the trench for them must be blasted out. Finally small shots are used for trimming the sides of the cut and minor irregularities are taken off with a plug and feather. Joseph F. Ledger is superintendent in charge of the blasting.

Concreting Procedure—The highway structure consists of parallel concrete retaining walls, piers and columns spanned by steel girders supporting the upper deck consisting of a reinforced-concrete slab. The walls and piers are indicated by Fig. 3, as well as the method of placing concrete. A 21-E paving mixer operating on the north bank of the cut has economically solved a rather difficult concreting problem. The south bank was inaccessible except from one end, and here the relocated street railway interfered. Again concreting trucks or a mixer in the bottom would have interfered with the excavating work just ahead. A mobile plant

FIG. 3—GENERAL VIEW OF CONSTRUCTION, NEW JERSEY APPROACH ROAD TO HOLLAND TUNNEL
Blasting operations in distance. Paving mixer on right bank chutes concrete to hopper in cut from which crane handles to left side of cut. Offices, compressor plant, etc., on left. Steel girders to be placed across cut carry upper deck of highway.

was, of course, best for a running job. The concrete for the north side of the structure is chuted directly from the paver to the forms. For the south side a hopper holding three mixer batches is placed in the bottom of the cut, as shown in Fig. 3. Bottom-dump buckets of a ¾ cu.yd. capacity receive concrete from this hopper and are hoisted to the forms by a crawler crane with a 46-ft boom. This operation is practically as fast as the direct chuting used on the north wall. Batch trucks are used for charging the paving mixer, the batches being made up at the material pier several miles distant. A wall form consists of three 12-ft. sections about 25 ft. high. Each section is moved as a unit and is placed by the crane. About a form a day is the average concrete run. A 1:2:4 mix is used.

Administration—The work is being carried out by the engineering and construction forces of the Public Service Production Co., Newark, N. J., of which N. A. Carle is vice-president, in charge of operation, and R. A. Finley, superintendent of construction in the field. The job is a part of State Highway Route No. 1 Extension, and is known as Section No. 2. Fred Lavis is engineer for the New Jersey State Highway Commission.

Hydraulic Data on Rapidly Rising Flood in Small Stream

Squillchuck Creek in Central Washington Has Flood of Great Concentration Though Observed Rainfall Was Low

By D. J. F. Calkins
Assistant Engineer, U. S. Geological Survey

LAST fall a rapidly rising flood on a small stream in the state of Washington, Squillchuck Creek, caused damage to highways, railroad yards and buildings to the amount of $130,000 and the death by drowning of 14 persons. Since the flood a study of its hydraulic data has been made and is offered here as of interest in the study of similar floods.

Squillchuck Creek, with a tributary area of 27.2 square miles, drains a portion of the northeastern slope of Wenatchee Mountains in the southeastern part of Chelan County, Washington. These mountains, within the limits of the drainage basin of Squillchuck Creek, rise from an elevation of about 600 ft. at the mouth of the stream in Columbia River at Wenatchee, to about 6,820 ft. at the summit of the divide, or about 6,200 ft. in a distance of eleven miles, the approximate length of the main stream and drainage basin. The creek forks about two and one-fourth miles above the mouth. The general direction of flow of the main stream and its principal tributary, Pitcher Canyon, is northeast.

The topographic map of the area (Wenatchee Quadrangle) shows several short, steep, intermittent tributaries coming in from the south, below or near the mouth of Pitcher Canyon. These tributaries are dry for much of the year and function as water courses ordinarily during the early spring. They average little more than a mile in length but the principal ones shown rise considerably more than 1,000 ft. in their length and have their axes almost directly in line with a down Columbia River wind.

The upper reaches of the drainage area of Squill-

chuck Creek lie within the Wenatchee National Forest and are timbered, but the lower reaches near the mouth of Pitcher Canyon and the slopes of the intermittent tributaries mentioned support little vegetation except immediately adjacent to the main stream.

Precipitation—There was a storm in the creek basin on the afternoon of Sept. 5, 1925, which must have reached cloudburst proportions on certain parts of the basin, though the Weather Bureau station "near Wenatchee," located at El. 2,210 ft. in Pitcher Canyon, recorded only 0.84 in. of rainfall for the day.

In discussing this storm in the "Summary of Climatological Data for Washington," September, 1925, the statement is made that the heavy rain was of but little more than 30 min. duration. It is probable that most of that recorded fell within that time. That intensity of rainfall, however, for so short a period, could hardly account for the resulting flood which caused great damage to life and property. Daily precipitations of several times the amount recorded on the date of this flood have been recorded at the station in Pitcher Canyon without causing severe floods.

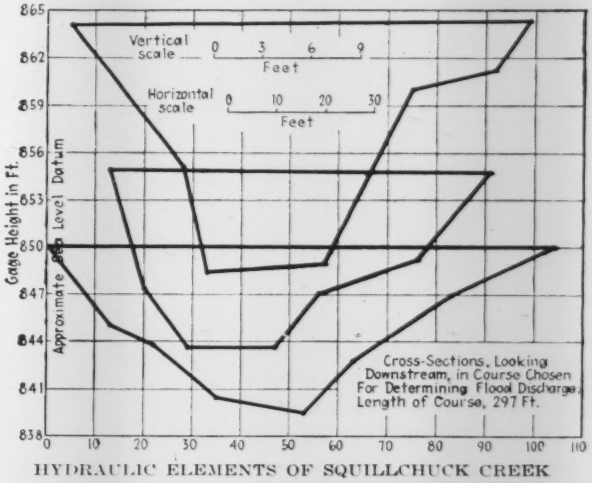
Field Investigation—Because of the resulting damage, it was considered of sufficient importance at the Tacoma office of the United States Geological Survey to make an examination of the area and determine if possible the flood flow. Accordingly Joseph S. Gatewood, junior engineer, was detailed to make a field examination and did so within less than a month after the flood.

This examination indicated that the greatest intensity of the storm must have been in the vicinity of the intermittent tributaries. They showed evidence of having carried enormous volumes of water, while the evidence of extraordinary flood was not so marked above their confluence with the main stream. It seemed advisable therefore to choose a stretch of channel as near the mouth of Squillchuck Creek as possible, in order to include runoff from this area of apparent greatest intensity, even though channel conditions were not the best for the purpose.

A stretch 297 ft. long was finally chosen about one mile above the mouth of the creek. In this stretch three cross-sections between flood marks were taken, and the slope of the peak discharge was determined from flood marks, still quite well defined; especially so along the right side, by the appearance of grass and by deposited drift, in the nature of small pieces of bark, etc. These sections are given in the accompanying drawing.

The left side of the stretch chosen was steep and of cemented gravel which did not cut easily and the water marks were not so easily traced. The right side had flatter side slopes. The entire area within this stretch which had been flooded was quite free of vegetation. The principal varieties noted were cottonwood trees and short grass. There were no bushes or sage brush to amount to anything. The cottonwood trees grew in small clumps. Evidence of only seven or eight such clumps were found within the whole stretch. The trees, the diameter of the largest of which was about one foot, had been torn down by the force of the water and stripped of their branches and most of their bark. The ground itself was quite smooth, and composed of cemented gravel and hardpan. There were no boulders at all and no rock ledges. The ordinary streambed is loose sand and gravel. The whole would indicate that a rather low, than otherwise, value of n might be used in Kutter's formula.

Results of Computations—From the data tabulated in the drawing, by the application of Kutter's and Chezy's formulas, results showing a mean peak velocity of from 29.7 to 38.7 ft. per second and a peak discharge of from 19,000 to 25,000 sec.-ft., depending upon whether $n = 0.040$ or 0.030 were applicable to channel conditions, were obtained. These discharges would represent an intensity of runoff of from 715 to



HYDRAULIC ELEMENTS OF SQUILLCHUCK CREEK

	Upper Section	Middle Section	Lower Section	Mean
Area	786.6	569.4	593.0	649.6
Wetted perimeter	102.8	83.7	106.6	97.7
Hydraulic radius	7.65	6.81	5.56	6.67

NOTE:—Average slope between upper and lower sections—0.04756.

940 sec.-ft. per square mile, for the 26.6 square miles of drainage area above the measuring section. Inasmuch as the evidence points to greater proportional runoff from the lower reaches of the drainage area, the intensity of runoff there must have been very great.

Causes—In further discussing this flood the above mentioned Weather Bureau report states that it was caused by the breaking of dams formed of débris of various kinds carried down the steep and narrow valley. This may be true to some extent. The very steep slope determined from water marks in the stretch of channel considered here, however, makes it certain that these marks were not left by impounded water, and appearances in the canyon would not wholly support the theory of breaking dams. It seems probable that a storm area centering over the heads of the intermittent tributaries or south of them drew the hot moisture-laden atmosphere overlying the Columbia River and its tributary irrigated valleys toward its center. The rapid rise of the atmosphere through the steep ravines probably resulted in very heavy precipitation which seems more likely to have been responsible for the flood than the bursting of dams of débris in the main valley.

Federal-Aid Roads Now Total 52,526 Miles

Federal-aid roads brought to completion during the fiscal year ending June 30, 1926, amounted to 10,628.3 miles, according to the Bureau of Public Roads. The total mileage of completed federal-aid roads is 52,526 miles. The new fiscal year was begun with 14,355.1 miles under construction and 2,483 miles approved for construction.

New York's Third Subway Under Construction

Eighth Avenue Line from 111th to 122nd St., Manhattan, Called for Unusual Underpinning Methods in Transferring High Elevated Railway Columns to Roof of Subway

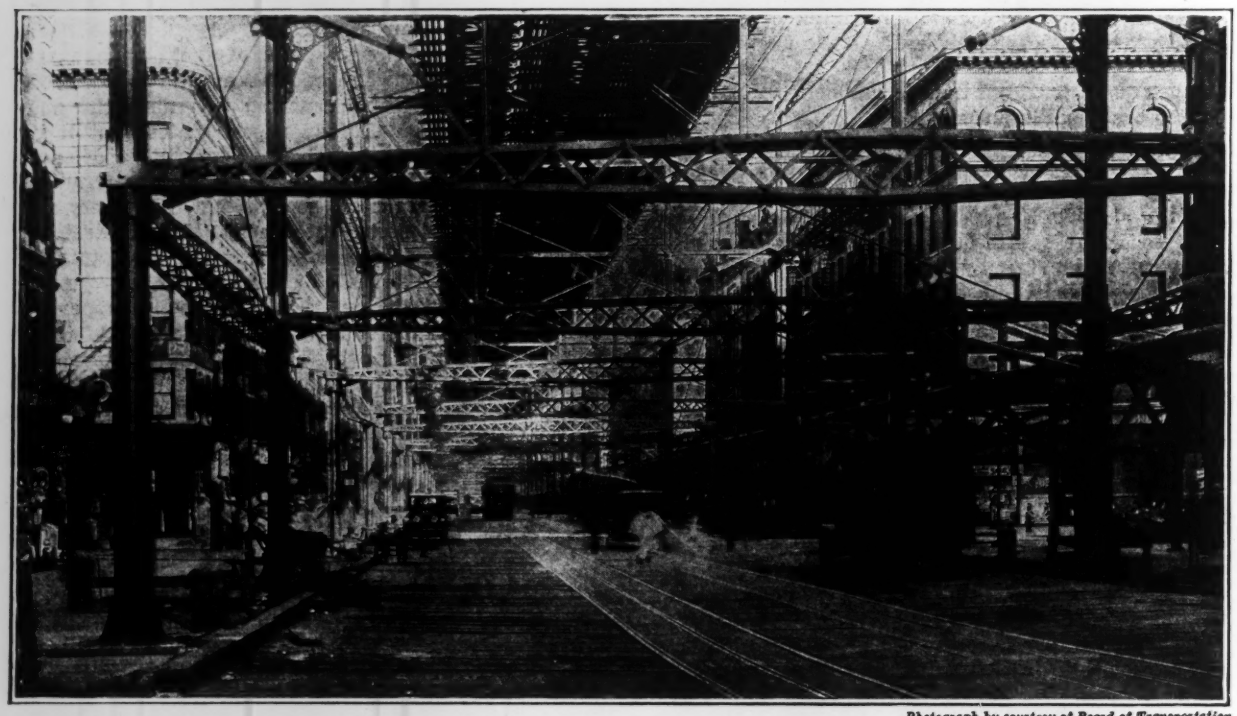
By Lazarus White

President Spencer, White & Prentis, Engineers and Contractors, New York

Continuing a series of articles on rapid-transit subway construction now in progress in New York, where a complete new network of lines is being added to those built in 1900-1904 *and* 1913-1918. *The first article, June* 17, 1926, *p.* 970, *outlined the planning of the new system. Succeeding articles on separate sections of the work have appeared, July* 8, 1926, *p.* 60, *July* 22, 1926, *p.* 142, *and Aug.* 5, 1926, *p.* 216.

On Section 3, Route 78, there were about 100 elevated railway columns to be underpinned, these columns being mostly on the sidewalks just inside the curb line. This article describes the underpinning methods. The contract for Section 3, Route 78 (Eighth Ave. Subway) 3,000 ft. long, provided for the excavation of 200,000 cu.yd. of which 20,000 yd. are estimated to be rock fill and the remainder sand and gravel. The upper end is in filled ground and above ground water level and the lower end is in original sandy gravel about 6 ft. below ground water level. There were in the original contract about 30,000 cu.yd. of concrete to be placed and 3,300 tons of steel to be erected. The total contract price is about $4,900,000, and the contract time is 42 months. Eighth Ave. is about 100 ft. wide and is lined with five-story tenement houses with stores at sidewalk level. The subway averages about 60 ft. in width, is standard four-track (one-level) construction, and there is a local station at 116th St. Construction methods were described in "Engineering News-Record," Aug. 5, p. 216.—Editor.

AN EXCEPTIONAL underpinning problem existed on Eighth Ave., from 111th to 121st St., where for ten blocks the Ninth Ave. elevated railway, a 5-story structure, extended directly over the four-track subway line. Here the subway cut was 25 ft. deep and over 60 ft. wide in rock fill, sand and gravel. The task was to hold the elevated structure during the construction of the subway and then transfer its support to the roof of the completed underground structure. Because of the height and age of the elevated structure a tedious operation was promised. As actually carried on it has been a rapid operation. The August 5 article described the subway excavation methods, here only the special underpinning operation is considered. However, to the credit of Heyman & Goodman, Inc., contractors for this section, it may be said after only one year of work the entire underpinning is completed, nearly all the excavation has been removed and several



Photograph by courtesy of Board of Transportation

FIG. 1—ELEVATED RAILWAY REQUIRED COLUMN UNDERPINNING

View at Eight Ave. and 111th St. Note height of structure and street decking under which excavation is complete.

blocks of subway structure are completed including the transfer of the columns of the elevated to the roof of the subway. In money value about 70 per cent of the work has been completed in about one-quarter of the allotted time.

Elevated Structure—About fifty years ago, the Ninth Ave. elevated road was extended northward into Harlem. As Ninth, or Columbus, Ave. terminated at 110th St., the railroad was forced into a reverse curve around Morningside Park, at this point leaving a hill to the south and traversing the low lying Harlem plain to the north. The structure has a height exceeding that of the adjoining five-story building and for a considerable

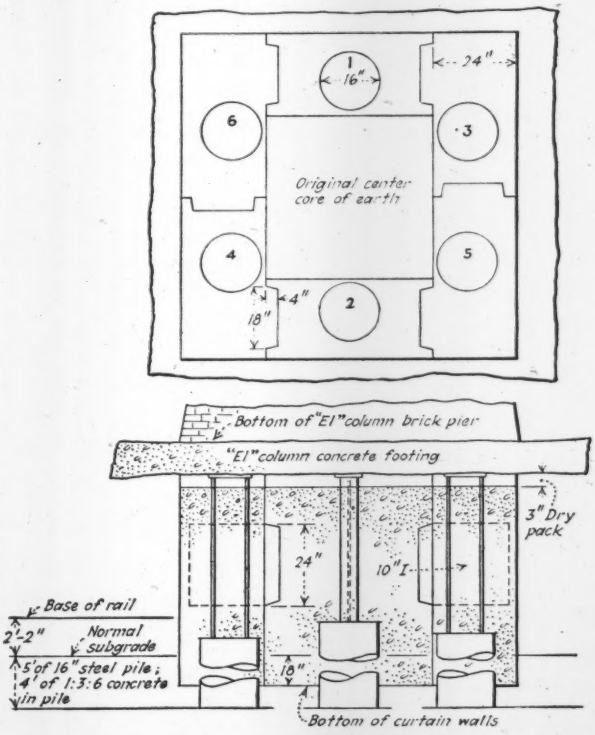


FIG. 2—TYPICAL COLUMN UNDERPINNING DIAGRAM
Brick pier and footing held up by inserting 16-in. piles, one at a time in order numbered, underneath. Piles pretested to 30 per cent over their working loads.

time was one of the sights of the city of New York, considered by engineers to be an outstanding feat of steel construction. It consists of pin-connected trusses and Phoenix columns as shown by Fig. 1. The structure subsequent to its erection was stiffened by additional cross bracing. The present level of Eighth Ave. north of 110th St. is about 25 ft. above that of the original plane, and at 120th St. the grades meet. In most cases the original builders were very conscientious in securing a good foundation, digging down to firm material. At 112th St. it was necessary to penetrate about 6 ft. of pond muck to secure a good footing. The brick piers supporting the structure were founded on layers of rough concrete of varying thickness, the brickwork ranging in height from 15 to 30 ft. and having an area at the base of about 100 sq.ft. The column was cemented into a large base casting with a "rust" joint, the casting being bolted down with four large bolts extended through a bonding stone about half way

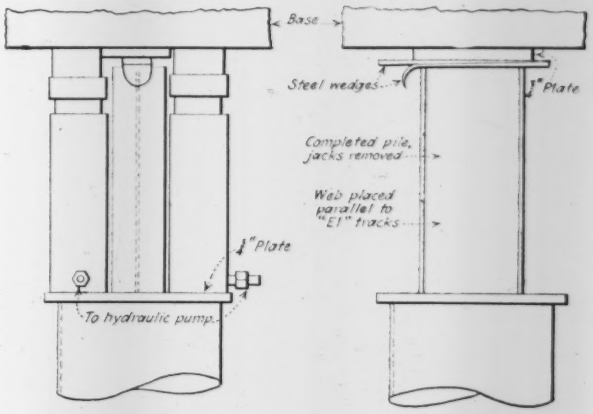


FIG. 3—ARRANGEMENT FOR PRETEST WEDGING
When gage on hydraulic jacks shows load 50 per cent in excess of working load steel wedges are inserted on top of I-beams cut to fit and are driven until rebound of pile is prevented.

down the pier. The brickwork was laid in a cement said to be an imported portland and was found to be in excellent condition, as were also the wrought-iron bolts.

Underpinning—In previous work of underpinning elevated railway columns in New York the track girders have been supported by wooden towers from the street surface or else plate girders have been directly attached to the columns, enabling the excavation to be carried on immediately below the columns and the original column base to be removed. Here there were serious objections to either of the methods mentioned. The wooden towers would have had to be of great height and exposed to danger of fire and collision. For supporting plate girders it would have been very difficult to secure

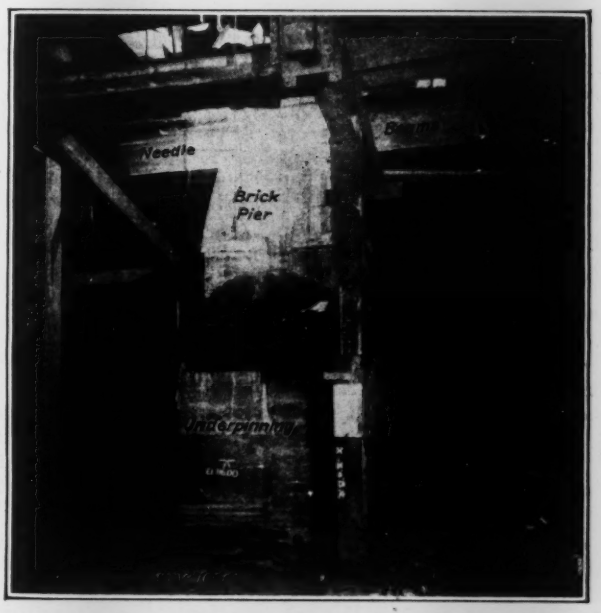


FIG. 4—UNDERPINNED PIER LAID BARE BY EXCAVATION

proper connections to the Phoenix columns. It was therefore decided to underpin the supporting brick piers from below and use only permanent materials in this

work, that is, to underpin the columns as if the underpinning was to remain permanently in place, even though it might be removed within a year.

Referring to Fig. 2, it will be seen that the main supporting members are six concrete-filled steel tubes

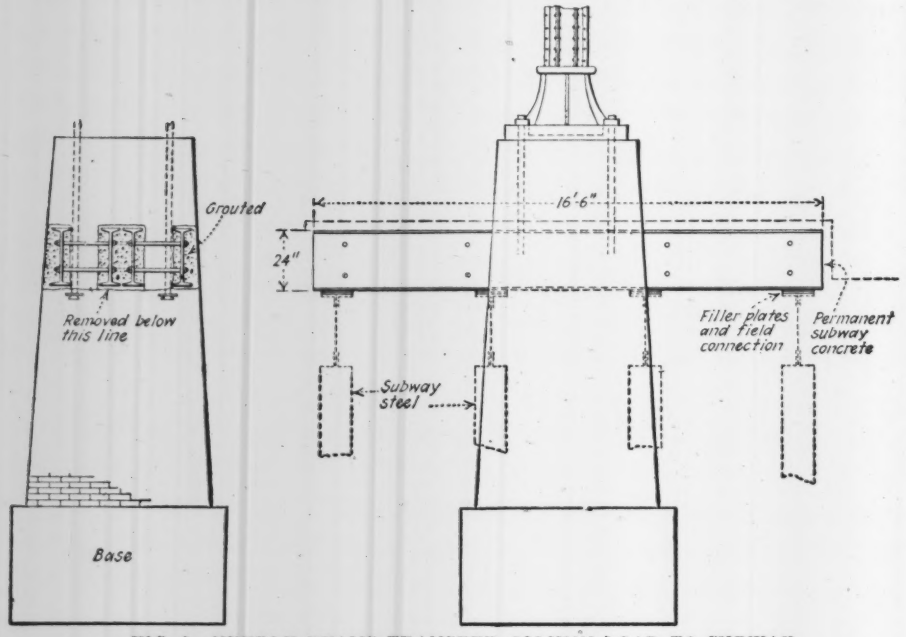


FIG. 5—NEEDLE BEAMS TRANSFER COLUMN LOAD TO SUBWAY
These beams are inserted after pier is underpinned but before it is laid bare by excavation.

16 in. in diameter and about $\frac{3}{8}$ in. thick. Each tube was placed within a horizontally sheeted pit and jacked down hydraulically to about 5 ft. below subgrade, and then filled with concrete and by the pretest method tested to about 30 per cent over the working load it was figured to carry. In this method two hydraulic rams are placed upon a steel plate at the top of the pile and pressure is applied by a hand operated pump connected to the rams by flexible copper tubing. As soon as the pile bears its test load without settlement an I-beam is cut to fit the space between the cap and the bottom of the footing and is securely wedged in place, so that upon removal of the jacks the rebound of the pile is held to $\frac{1}{32}$ in. A detail of the pretest wedging is shown by Fig. 3.

The operations described complete the underpinning of the columns as far as necessary to enable the excavation to be carried to the designed subgrade of the subway, but do not make any provision for the transfer of the elevated column to the roof of the completed subway. This was accomplished by inserting four needle beams directly into the brickwork of the pier. First a central slot was cut about 30 in. below the base of the casting and of a dimension just sufficient to allow the placing of the two central needle beams shown in Fig. 5. These beams were 16 ft. 6 in. long and weighed from 90 lb. to 120 lb. per foot. The cutting of the central hole, a delicate operation, was accomplished by jackhammer drills clamped to a frame attached to the column base. The holes were drilled through from one side. After the holes were drilled they were broached out by air-operated concrete breakers. When the central beams were grouted in, slots, by similar methods, were cut on each side of the pier and a third and fourth beam placed. It was required that these needle beams be placed before any excavation was made beneath the piers.

After the operations described were completed, the excavation for the subway was completed for the full width and depth, the material surrounding the piers and the underpinning below the piers being taken out with the main excavation. Fig. 4 shows an underpinned

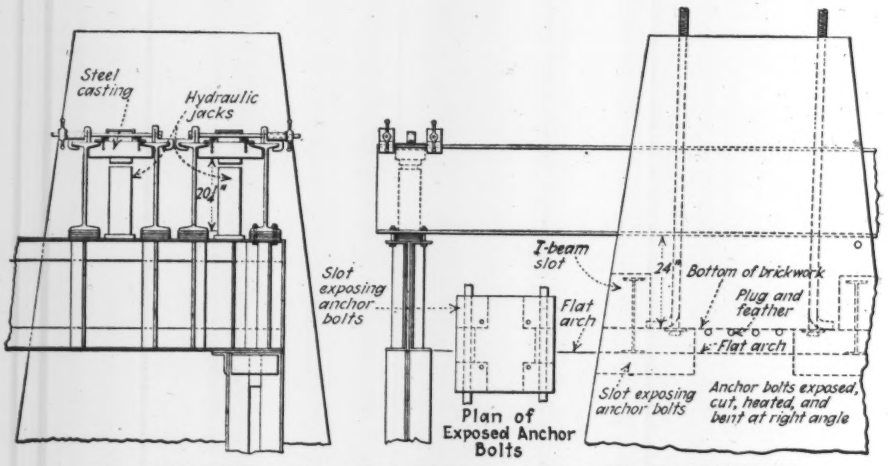


FIG. 6—TRANSFERRING LOAD FROM PIER TO SUBWAY STRUCTURE

pier after excavation. The material encountered at subgrade was mainly sand and gravel. After the concrete invert was placed steel bents were erected not on the customary 5-ft. spacing but at spacing to accommodate the needle beams in the brick piers in the manner as shown in Fig. 5. The girders supporting the needle beams and the beams themselves were field drilled and temporarily bolted together, after which shims were placed filling the gap between them.

The next step was to expose and cut anchor bolts. These anchor bolts were cut by an acetylene torch, and heated and bent at right angles to form a hook. The original brickwork remaining was then drilled so as

to establish a plane of cleavage. Special steel castings were inserted between the flanges of the I-beam and by means of four hydraulic jacks shown in Fig. 6 the column was raised about ⅜ in. and by aid also of plugs and feathers the pier was split at the drill holes as planned. The apparatus worked perfectly, and the operation of raising the column, inserting the necessary shims between the grillage beams and the supporting girders was often done in about 15 minutes. This operation not only tested all the supporting members but also the footings of the steel subway columns designed to carry the load of the elevated column. These footings were ordinary grillage footings.

To secure a good footing in the neighborhood of 111th and 112th streets, it was necessary to go several

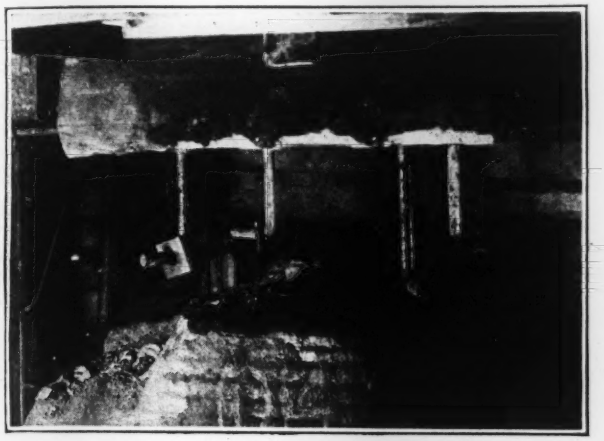


FIG. 7—REMOVING OLD PIER AFTER TRANSFERRING LOAD TO SUBWAY STRUCTURE

feet below the main subgrade of the subway to the bottom of the original pond, a firm mixture of sand and gravel. This is about the level of the original elevated column footings. It was not necessary to interrupt trains during any of the transfers. By means of gages attached to the hydraulic apparatus the actual load of the columns was measured. This was found to be about 60 tons, but the dead load of the original pier was about as much. Where columns were not to be supported on the roof of the subway no needle beams were inserted, and it was not necessary to go through any transfer operations. At St. Nicholas Ave., the spans are large and the loads on the columns are correspondingly greater; at some eight underpinning piles were used.

After the transfer operations were completed about 2 ft. of brickwork below the plane of cleavage were cut out by concrete breakers (Fig. 7) and the remainder of the old brick pier was drilled and blasted, using light charges of powder; then two partial bents of steel were erected and the sidewall concreted, the last operation being the concreting of the roof and the grouting of the space between what remained of the original pier and the roof of the subway.

During the transfer operations it was noted that there were only very slight deflections of the grillage beams and supporting girders, indicating ample factors of safety in the supporting steel. Accurate elevations were kept on the elevated columns during all stages of the underpinning and transfer operations. During the underpinning operations only slight settlements were noted, the average being less than ¼ in. Final elevations of columns were ½ in. above original grades.

It will be noted that the main effort of these underpinning operations was to secure maximum safety, using a permanent construction for what is described in the contract as a "temporary support of the elevated railroad.' Also that by the method of transfer used any settlements occurring during the underpinning operations could be very easily corrected, and that unless these settlements were sufficient to introduce undue stresses in the structure they were of no consequence. By April 1, 1926, all the columns were underpinned, about 100 in all, and several blocks of the elevated railway are permanently transferred to the subway roof without the slightest observable damage to the structure.

Organization—The method described although new to this class of work has been repeatedly used in connection with the underpinning of buildings, and is a patented method known as the Pretest Method of underpinning, Heyman & Goodman, Inc., the contractors, having been licensed by Spencer, White & Prentis, Inc., to employ the method for the described work. All construction is under the supervision of the Board of Transportation, New York City, Robert Ridgway, chief engineer.

Plaster-Protected Steel-Joist Floor in 4-Hour Fire Test

A 4-hr. fire test of a steel-joist floor with ¾-in. hard-plaster ceilings was recently carried out by the Pittsburgh Testing Laboratory. Both the plaster ceiling and the steel joists resisted the long exposure successfully. The test floor was 6x10½ ft. The panel was spanned in the long direction by five steel bar open-web joists (Massillon, type 8C) spaced 16 in. on centers; the joists were covered on top with ⅜-in. 4-lb. ribbed metal lath fastened at 8-in. intervals with hardwood wedges and a 2-in. concrete slab with ¼-in. temperature bars 12 in. on centers and surfaced with ½-in. finish was poured on top of the lath. To the lower side of the joists were wired ⅞-in. channels 12 in. on centers which carried 3.4-lb. flat diamond lath for plastering. A thickness of ¾ in. of ceiling plaster was applied to this lath, the scratch coat, ½ in. thick, being of portland cement mortar with hydrated lime, wood fiber and hair, while the second and third coats were standard gypsum plaster. This floor was built over a brick oil-heated furnace, and was provided with pyrometers extending into the interior of the furnace and into the hollow interior of the floor construction. It was loaded to full design load, 125 lb. per sq.ft., throughout the fire test. The furnace reached 1,800 deg. temperature in about 45 min. and was kept approximately at this temperature for 3 hr. 40 min. thereafter. The temperature in the interior of the floor construction rose from 400 deg. F. at the beginning of the 1,800-deg. period to 700 to 1,000 deg. F. at the end of the period. At the expiration of the test the temperature on top of the floor slab ranged from 160 to 170 deg. F. The deflection of the panel increased from ¾ in. to 1⅛ in. No hose stream was applied, but the furnace was allowed to cool. The ceiling was found in practically perfect condition, the laboratory's report states. Slight lateral and vertical distortion of the joists was found, after removal of the floor slab, but the joists were still capable of carrying twice the design load.

Working Tests Show Direct Oxidation Not Suitable for Sewage of Allentown, Pa.

Skimming-Detritus Tanks, Imhoff Tanks, Sprinkling Filters, Disinfection and Humus Tanks Advised—Summary of Direct-Oxidation Tests—Costs of Treatment

AFTER an investigation of sewage disposal conditions at Allentown, Pa., which included a seven-day working test of the direct-oxidation plant which treats the sewage from some 10 per cent of the population of the city, Metcalf & Eddy, consulting engineers, Boston, Mass., recommended a plant to serve the entire city, consisting of coarse racks ahead of electrically-driven centrifugal pumps, grease skimming-detritus tanks, Imhoff tanks, sprinkling filters, chlorination apparatus and humus or final settling tanks. A high degree of treatment is advised because the effluent would go into the Lehigh River above the water-works intake of Bethlehem. The report states that the direct-oxidation plant now in use is not suitable to treat the sewage of the whole city, "due to the fact that the purification effected is inadequate, the operating charges high and the quantity of sludge produced excessive." The general plan advised in the report, we are informed by Earle W. Meckley, city engineer of Allentown, has been approved by the Pennsylvania Department of Health. A bond issue to provide construction funds will be submitted to the voters in November, it is expected.

The population of Allentown in 1920 was 73,502. The Census Bureau estimate for July 1, 1925, was 92,151, taking into account territory annexed since 1920, and the estimate of the consulting engineers for the same date was 90,400. Sewage-works plans should be based on a population of 128,000 in 1935 and an average dry-weather flow of 17.3 m.g.d., although it is not expected that sewer connections for that number of people will have been made by that time. At present, only some 9,000 or 10,000 population is provided with sanitary sewers but the city is fairly well provided with storm sewers, which receive some industrial wastes. The drainage area of the Lehigh River above Allentown is about 1,045 sq. miles.

Proposed Plant—Kline's Island is proposed as a site for the sewage-works. The grease skimming-detritus tanks would give average and minimum detention periods of about 15 and 10 min. Provision would be made for removing the settled solids by the continuous pumpage of about 20 per cent of the inflow from the bottom of the tanks. This material would pass at a velocity of about 1 ft. per sec. through grit chambers in which sand and other mineral matter would be deposited and from which the lighter suspended solids would pass with the effluent to fine screens and thence to the main channels leading from the skimming-detritus tanks to the Imhoff tanks. Both the oil from the skimming tank and the material retained by the fine screens would be burned, either at the garbage incinerator or in an incinerator built for the purpose. The humus tank sludge would be returned to the digestion compartment of the Imhoff tanks and the sludge from the latter would go to drying beds. The report suggests disposal of the dewatered sludge to farmers.

The estimated first cost of sewage-works, exclusive of land, to treat 17.3 m.g.d. is $1,902,600, or $110,000 per m.g.d. capacity, and the operating costs $80,000 a year or $12.50 per m.g. treated. Including $20.50 for fixed charges, the total yearly cost would be $33.05 per m.g., compared with the following for three alternative projects: Sedimentation—activated sludge, with separate sludge digestion with heat, $37.03; Imhoff tank—activated sludge, with sludge digested in Imhoff tanks, $40.40; activated sludge, with sludge dewatered, $45.60. Land is excluded in all cases but 20 per cent is allowed for engineering and contingencies and final disinfection is also included.

Test of Direct-Oxidation Plant—The test of the lime-electrolytic or direct oxidation plant extended seven days from 8 a.m., Monday, Oct. 26, 1925, during which period the meters and gages were read and samples of sewage and effluent collected every half hour. This plant was built in 1921 and at the time of the test was treating sewage from an estimated population of 10,170. The plant has a nominal capacity of 3 m.g.d. From the pump well sewage is lifted to a concrete trough from which it passes through a coarse rack (¾-in. rods, 3 in. c. to c.) to slightly inclined plate screens with ¼-in. perforations. The screened sewage goes to grit chambers 14 ft. long, 8 ft. wide, and 2¾ ft. deep below the crest of the overflow weir. Thence it passes through a Venturi meter (provided with a by-pass) to a concrete tank in which powdered lime is mixed with the sewage by the swirling motion of the latter.

There are three electrolizers, each of 1 m.g.d. rated capacity. In the unit tested the original revolving-paddle-cleaned steel electrodes were replaced in 1923 by an arrangement of brass, Armco iron and steel plates, cleaned with scrapers that move up and down. Deducting space occupied by the scrapers the electrolizer area in the unit tested is given by the promoters of the process as 102,300 sq.in. instead of 126,931 in the other units. The limed sewage passes from the electrolizer to an open settling basin which gives a theoretical detention period of 4.7 hr. with a 1-m.g.d. flow and the basin free from sludge. The original perforated-plate and drain system of sludge removal, and also the original sludge-drying beds, are no longer used. The perforations clogged and it took too long to dewater and remove the sludge. Sludge is now lagooned.

Detailed operating results for the week of the test are given in the report together with text summary and comment here condensed somewhat:

Organic Nitrogen—The electrolizer effluent showed no change in total organic nitrogen. The proportions of dissolved and suspended organic nitrogen, however, were distinctly altered, the dissolved organic nitrogen being materially increased and the suspended organic nitrogen being decreased by the same amount. The increase in dissolved organic constituents was probably due to the solvent action of the caustic lime. Sedimentation in the settling basin resulted in a decrease of about 19 per cent in the total or-

ganic nitrogen, made up largely of a decrease of 60 per cent in the suspended nitrogen. Complete treatment effected a 19 per cent removal of organic nitrogen from the sewage.

Albuminoid Nitrogen—The lime-electrolytic treatment, prior to sedimentation, brought about no decrease in the total albuminoid nitrogen; in fact, the analyses indicate a slight increase. As was the case with the organic nitrogen, there was a distinct change in the proportions of dissolved and suspended nitrogen, the dissolved increased and the suspended decreased. The sedimentation basin effected a removal of approximately 29 per cent of the total albuminoid nitrogen comparing the effluent of the basin with its influent, and 58 per cent removal of the suspended albuminoid nitrogen. A slight decrease occurred in the dissolved nitrogen. Complete treatment effected a 26 per cent removal of albuminoid nitrogen from the sewage.

Ammonia Nitrogen—The ammonia nitrogen was approximately 29 per cent less in the electrolizer effluent than in the untreated sewage. A decrease of 15 per cent in ammonia nitrogen also occurred in the sedimentation basin. The total reduction in ammonia nitrogen by the plant was 33 per cent. Lime tends to liberate free ammonia nitrogen and it is impossible to state to what extent the reduction in this constituent was due to such reduction.

Nitrite and Nitrate Nitrogen—The analysis of the electrolizer effluent shows somewhat larger quantities of nitrite and nitrate nitrogen than the analysis of the sewage. This result apparently indicates that the lime-electrolytic treatment effected some measure of oxidation of nitrogenous matter. It should be noted that all samples were made up of individual portions collected over periods of 24 hours and that no preservative was added until the end of the 24 hours. Consequently the sewage samples had opportunity to undergo denitrification as the result of bacterial action during the few hours they were kept before the addition of preservative. In the case of the electrolizer and basin effluents the excess lime added would act as a preservative and would prevent denitrification.

To determine the extent of oxidation of nitrogen during the passage of the lime-treated sewage through the electrolizer, several catch samples of electrolizer influent and effluent were collected at various times during the test. The effluent samples were collected one or two minutes later than the influent samples, in order to obtain as nearly comparable samples as possible. Several comparable samples of the basin effluent were also collected. The average results of the analyses of these special samples for nitrite and nitrate nitrogen are: Electrolizer influent, 0.46 p.p.m.; electrolizer effluent, 0.52; basin effluent, 0.51. These results indicate little change in nitrite and nitrate nitrogen during the passage of the lime treated sewage through the electrolizer and basin. Such slight average change as is indicated lies within the limits of accuracy of sampling and analysis.

Oxygen Consumed—The analysis of the electrolizer effluent shows a small increase in carbonaceous matter as measured by oxygen consumed. The complete treatment, however, brought about a 39 per cent reduction in total and an 89 per cent reduction in suspended oxygen consumed.

Solids—Due to the addition of the lime, the total solids were materially increased by the lime-electrolytic treatment. In the final effluent the total solids, dissolved solids and suspended solids were materially less than in the raw sewage. Due to the action of the lime as a softening reagent the quantity of inorganic matter precipitated with the sludge was very considerable, thus increasing the quantity of sludge to be provided for. The suspended solids in the final effluent were 50 p.p.m. or 36 per cent of the suspended solids in the sewage. The total solids in the final effluent were 440 p.p.m. or 67 per cent of the total solids in the sewage.

Chlorides—The chlorides were substantially the same in all three samples, indicating the accuracy of the sampling.

Alkalinity—The alkalinity was changed from bicarbonate to carbonate alkalinity by the treatment and precipitated in part. The average results of half-hourly titrations of samples of the effluents during the test run showed distinctly larger quantities of causticity. A small amount of hydroxide or caustic alkalinity remained in the sample effluents by the time they were analyzed. This fact indicates that the caustic alkalinity originally present in the effluents was neutralized by carbon dioxide absorbed from the air during the time elapsing between sampling in Allentown and analysis in Boston.

Bio-chemical Oxygen Demand—The bio-chemical oxygen demand (5 days' incubation) was somewhat larger in the electrolizer effluent than in the sewage. There was, however, a distinct reduction in bio-chemical oxygen demand in the settling basin. The whole process resulted in a decrease of 66 p.p.m. of oxygen demand or 35 per cent.

A few special catch samples of influent and effluent of the electrolizer were collected and, after settling, oxygen demand determinations were made on the supernatant liquid. These showed 125 p.p.m. in the electrolizer influent and 117 in the effluent.

Relative Stability—Portions of the daily composite samples of the basin effluent were neutralized with acid and then seeded with a few drops of sewage. These neutralized and seeded portions were used for making the standard relative stability test with methylene blue. Without the neutralization and seeding, the tests would be of little value due to the disinfecting action of the excess causticity. Under ordinary conditions effluents are discharged into natural bodies of water which will neutralize such excess causticity and will contain bacteria for seeding. The final effluent remained stable only one to two days, giving a relative stability ranging from 21 to 37 per cent, averaging approximately 30 per cent.

Bacterial Analyses—Samples for bacterial examination were usually taken in the early morning and again during the middle of the forenoon or afternoon. The analyses were made by Mr. Krum, city chemist and bacteriologist, and his assistants. The times of sampling were selected with the view of obtaining bacterial results typical of weak night sewage and of strong day sewage.

The average results of the bacterial examinations during the week of the test run were:

Agar Count—24 hr. at 37 deg. C. per c.c.				B. Coli per c.c.—presumptive			
Raw Sewage	Electrolizer Influent	Electrolizer Effluent	Basin Effluent	Raw Sewage	Electrolizer Influent	Electrolizer Effluent	Basin Effluent
768,690	77,890	77,287	2,330	122,500	6,801	8,825	724

Results for No. 1 excluded due to abnormally high count in electrolizer effluent.

A reduction of approximately 90 per cent in total bacteria was secured by the addition of the lime. The electrolizer appeared to bring about no further reduction in bacteria but the basin effluent contained about 0.3 per cent only of the bacteria present in the raw sewage.

In case of organisms of the B. Coli type the addition of the lime brought about approximately 94 per cent reduction. The electrolizer effluent contained on the average slightly more organisms of the B. Coli type than did the influent. The basin effluent contained about 0.6 per cent of the B. Coli present in the raw sewage.

To determine the effect of quiescent sedimentation upon the effluents several samples were allowed to settle for one hour and the supernatant liquid used for bacterial examination. The results were:

Agar Count—24 hr. at 37 deg. C. per c.c.			— B. Coli per c.c.—presumptive — Supernatant Liquid After 1 Hr. Settling		
Electrolizer Influent	Electrolizer Effluent	Basin Effluent	Electrolizer Influent	Electrolizer Effluent	Basin Effluent
1,739	2,551	1,404	13	19*	10

*Omitting one abnormally high count.

It will be seen that on the average the supernatant liquid in all three samples gave very nearly the same results, if one high result for organisms of the B. Coli type in the settled electrolizer effluent is omitted.

Sludge Produced—At the end of the test run the supernatant liquid was slowly drawn off from the westerly basin in such a way as to disturb as little as possible the deposited sludge. After as much supernatant water was drawn as feasible, the sludge was allowed to settle compactly, and measurements of its depth were made at regular intervals along and across the tank. From these measurements, a total quantity of 37,500 gal., exclusive of supernatant water, was found to have been deposited or an equivalent of 5,350 gal. per m.g. of sewage treated.

The sludge as pumped to the lagoon was sampled every

15 minutes. A certain amount of settled sewage was required to mix with the sludge to facilitate pumping. The sludge sample contained, therefore, more water than the sludge lying in the tank as measured. To obtain the average composition of the sludge as present in the tank, the sample was allowed to settle and the settled material was analyzed. From the measurement of sludge and its analysis, the quantity of dry solids has been computed to be 4,550 lb. per m.g. of sewage treated. From the analyses of the influent and effluent of the basin, the weight of dry solids removed was computed to be 4,630 lb. per m.g. The closeness of the results indicates the accuracy of the various measurements and determinations.

Cost of Treatment—The cost of operation of the present treatment plant in 1925 was as follows:

	Total	Per M.G.
Salaries (1 chief and 3 assistant operators and assistant city chemist)	$7,495	$20.90
Miscellaneous labor	1,400	3.90
Lime, delivered at plant	2,792	7.80
Power*	2,342	6.50
Supplies and repairs	2,319	6.50
Light and heat	511	1.40
	$16,859	$47.00

*Includes current for operation of sump pump.

As the total quantity of sewage treated was 359 m.g. the actual cost of treatment, exclusive of fixed charges, was $47 per m.g. of sewage. Inasmuch as a large proportion of the cost is made up of the salaries of the operators and in view of the fact that the same number of operators could probably care for the plant operating at its rated capacity of 3 m.g.d., we have prepared the following estimates of cost based on 1925 operation costs and with the plant at its rated capacity.

	Total	Per M.G.
Salaries (1925 schedule)	$8,490	$7.75
Miscellaneous labor (1 laborer)	1,326	1.20
Lime (1 ton per m.g)	13,195	12.05
Power* (2.8c per kw.-hr.)	7,150	6.55
Supplies and repairs (1924 and 1925 average pro rated)	5,600	5.10
Light and heat (1925 cost)	511	0.45
	$36,262	$33.10

*Exclusive of sump pump.

As regards fixed charges, it is difficult to make allowances for the life of the electrolytic units. The units, as originally put in, are already obsolete and one of the three has been remodeled. If the cost of replacing or remodeling these units were charged against the sewage treated to date, the fixed charge for obsolescence would be very high. It hardly seems fair, however, to estimate on a 5-year life of the electrolizers nor does it seem reasonable to adopt 30 years as the depreciation period, a period which is ordinarily allowed for semi-permanent structures such as brick buildings and concrete tanks. We have, therefore, made an estimate of fixed charges on the plant based on a 15-year life for the electrolizer units, and the results of our estimates are:

Item	Cost	Annual Interest and Depreciation Rate, Per Cent	Amount
Electrolizers and machinery	$134,590	9.994 =	$13,460
Building and sedimentation basin	73,779	6.783 =	5,000
			$18,460
		Per M.g. =	$16.85

Interest = 5 per cent depreciation annually; Electrolizers and machinery; 15-yr. life at 4 per cent = 4.994 per cent; building and sedimentation basin, 30-yr. life at 4 per cent = 1.783 per cent. Annual cost per m.g plant capacity: Fixed charges $16.85; operating charges, $33.10; total $49.95, say $50.

The table is based upon the assumption that the present treatment plant is capable of handling an average sewage flow of 3 m.g.d. Such an average flow means maximum flows at rates of 4.5 to 6 m.g.d. It is unlikely that the present plant could treat these high rates without modification of electrolizer units 1 and 3 to conform with unit 2. Furthermore a fourth unit would probably be required as well. If the cost of these additions and changes were added to the cost of the electrolytic equipment now installed there would result a material increase in fixed charges for depreciation and interest.

It should also be noted that these costs are computed on the basis of lagooning the sludge. If dewatering should be necessary the costs would increase accordingly.

Pennsylvania R.R. Builds New Freight Cutoff

Link Creating New Route Relieves Main Line and Allows Heavier Train Loads Between Bayard and Canton in Ohio—Fly-Over Junction

TO facilitate its heavy freight traffic between Pittsburgh, Pa., and Canton, Ohio, the Pennsylvania R.R. has built a 15-mile connection from Canton, on the main-line, to Bayard, on the Cleveland & Pittsburgh division, thus securing a shorter alternative route which has a ruling grade of 0.3 per cent as compared with 1 per cent on the main-line route through Alliance. Although there is a 9-mile stretch of from 0.5 to 1 per cent grade against westbound movements on the new route (but not on the Bayard-Canton cutoff), this is a pusher grade and does not affect the rating of train loads. At present the westbound loading for 0.5 per cent will balance the eastbound loading for 0.3 per cent grade. Curves do not exceed 2 deg. on the cutoff, except at the junction and the fly-over crossing of the main tracks east of Canton, where 4 deg. curves are required. Views of the heavy grading required on this line are shown in Figs. 1 and 2.

FIG. 1—HEAVY ROCK CUT, BAYARD-CANTON CUTOFF
Steam shovel clearing cut. Well drills putting down holes to blast bench at left.

The traffic situation is illustrated by the plan Fig. 4. At Canton, a division point on the Pittsburgh, Fort Wayne & Chicago line of the Pennsylvania System, there are large yards where freight trains are assembled for movements eastward and westward. Bayard is on the Cleveland & Pittsburgh line, which crosses the other at

FIG. 2—GRADING DEEP CUT ON NEW LINE, PENNSYLVANIA R.R.
Incline at left for removing excavated material to spoil bank

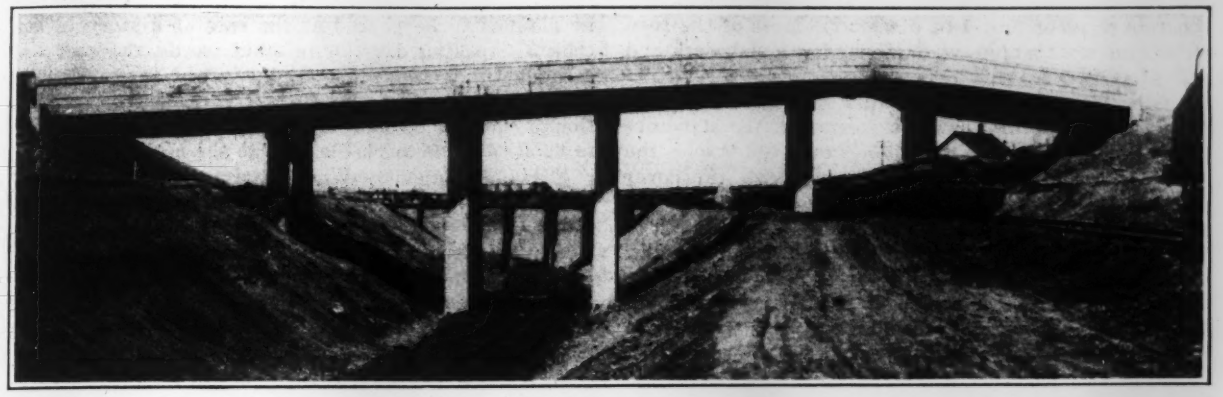


FIG. 3—CANTILEVER HIGHWAY BRIDGE
Bridge is in three sections, with cantilever ends over each track. Low-level eastbound track at left. Westbound track at right rising to cross over main line at the junction

Alliance. With the new connection, which is for freight service only, the heavy traffic over the Pittsburgh, Ft. Wayne & Chicago line between Canton and Pittsburgh will be relieved by diverting part of it to the shorter route over the Cleveland & Pittsburgh division, saving about 1.5 miles in distance. The improvement of the latter division for greater facility and economy in the

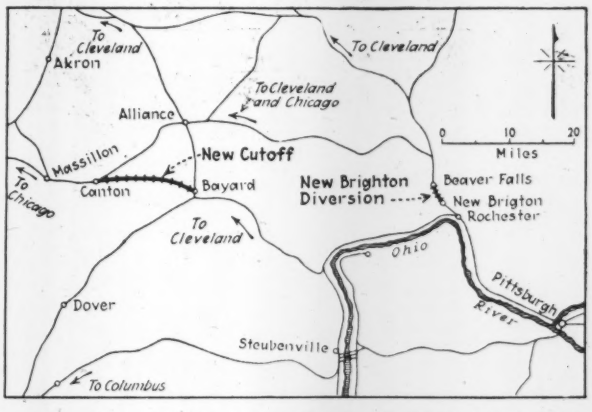


FIG. 4—BAYARD-CANTON CUTOFF, PENNSYLVANIA R.R.

handling of its heavy coal and ore traffic was described in *Engineering News-Record*, July 17, 1924, p. 88.

The rough character of the country traversed is indicated by Figs. 1 and 2, and the profile shows a succession of cuts and fills. There are no tunnels, but some of the cuts are 100 ft. deep. Fig. 1 shows a steam shovel cleaning up one side of a rock cut, while well drills are putting down holes for blasting out the bench at the left. Fig. 2 shows one of the long deep cuts, part

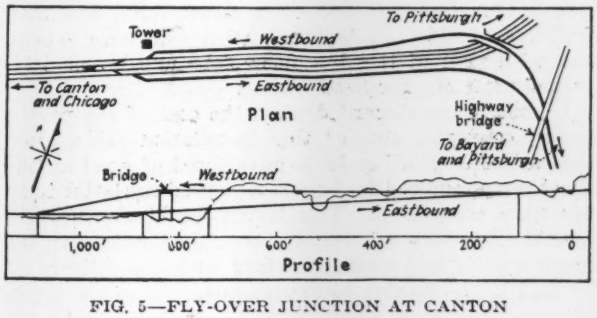


FIG. 5—FLY-OVER JUNCTION AT CANTON

of the spoil being removed over the incline and spur track at the left. The grading excavation amounted to about 2,250,000 cu.yd., and there are no borrow pits.

This will be a double-track line, with a roadbed width of 38 ft. on fills and 42 ft. in cuts, the slopes in earth averaging 1 on 1½. Where rock underlies the earth cover, the cuts have slopes of 1 on 1 or 1 on ¾ in the rock and then earth slopes of 1 on 1½ to the surface. Tracks will be laid with 100-lb. rails of the Pennsylvania R.R. section.

To avoid interference with the main line traffic, a flying junction is provided east of the Canton yard, the westbound track of the cutoff being carried over the four-track main line on a steel bridge and then running

FIG. 6—HIGHWAY ARCH BRIDGE OF 140-FT. SPAN

down to connect with the latter at an interlocking tower. This separation of grades is shown by Fig. 5 and also by the view, Fig. 3, where the low-level eastbound track is on the left and the high-level westbound track on the right. A highway bridge crosses at this point, beyond which is seen the temporary bridge for highway traffic. At Bayard, the line crosses the Tuscarawas branch and connects with the Cleveland & Pittsburgh division at grade. An electro-pneumatic interlocking plant will protect the crossing, the new junction and the old junction of the Tuscarawas branch.

Structures are rather numerous, as the railway has eliminated all highway crossings at grade, carrying the roads over or under the tracks. Subways have either arches of 30 to 40-ft. span or reinforced-concrete slab spans of 18 to 30 ft. Two 18-ft. subways have steel half-through girder spans with timber decks, where a shallow floor construction was necessary. Culverts are

concrete boxes 5 x 5 ft. to 12 x 12½ ft., or reinforced-concrete pipes of 2 to 4-ft. diameter. Most of the road structures are concrete viaducts having a slab deck and pair of girders carried by concrete piers.

In the highway bridge over the two-level connection near Canton, Fig. 3, it will be noted that the structure consists of three parts, with joints over the tracks, the central portion having a single span with cantilever projections to connect with similar cantilevers on the side spans. The arch bridge, Fig. 6, has a barrel arch of 140-ft. span with earth fill between the spandrel walls.

This new 15-mile link, which is to be opened before the end of 1926, will represent a total cost of about $4,500,000. Grading and masonry contracts were let to A. Guthrie & Co., St. Paul, Minn., the Ferguson & Edmondson Co., Pittsburgh, and the John F. Casey Co., Pittsburgh. The line was planned and built under the direction of Robert Trimble, assistant chief engineer, Pennsylvania R.R., and the work was in charge of B. V. Sommerville, assistant to the chief engineer.

Auxiliary Mixing Plant Cuts Cost on Warehouse

Second Plant Takes Small Work Off Central Mixer, Letting It Concentrate on Fast Schedule Laid Down for Main Structure

BY MARTIN LEAFGREEN AND J. J. LINDON

Cost Analyst and Superintendent, Respectively, Barney-Ahlers Construction Corporation, New York City

THAT it pays to analyze thoroughly plant operation and installation is shown by the experience in a nine-story structure in Long Island City. This particular operation proved conclusively that what at first might appear an unnecessarily large amount of equipment, in the end gave an actual saving, and it also demonstrated that it pays to put in small supplementary equipment to do special work and leave the main plant to do the work for which it is primarily intended. The special plant feature of this job was the installation of a half-yard mixing plant with an adjacent hod and brick hoist. This half-yard mixer supplemented the one-yard mixer of the main plant; was run by a separate gang; was kept constantly busy putting down the finished floor and doing the odd jobs, and was used to concrete the tower section which projected five stories above the main structure.

Warehouse Structure—The R. H. Macy & Co.'s warehouse at Long Island City, erected by the Barney-Ahlers Construction Corporation of New York, is of flat-slab construction, and is four stories 143 ft. x 200 ft., with a setback at the fifth story to 75x50 ft. and a further setback at the seventh story to 25x30-ft. elevator tower. The building is carried on spread footings over clusters of concrete piles. The walls in the four-story section are of brick and steel sash, while the setback portion is of steel sash and scored tile with a stucco finish. The building contains about 7,500 cu.yd. of concrete including 1-in. monolithic finish, 465 tons of reinforcing steel, 400,000 brick and 12,000 hollow tile.

Construction Problem—Analysis brought out the following problems: (a) A speed schedule calling for occupancy by the owners Aug. 1, the piledriver being scheduled to leave the site, May 1. (b) To meet this schedule the concrete structure of nine floors had to be planned to be poured at the rate of a story in less than 5½ working days, or in other words, the roof was scheduled to be topped out by the last of June. (c) The plant had to be designed to take care of mass production of concrete to the fourth story or main roof and also to hoist concrete brick tile, etc., to the ninth-story level.

Study of Layouts—When studying the problem of plant design, having in mind that "ready-mixed aggregate" (the local term for a combined sand and gravel) was available in 5-cu.yd. truckload lots at a five-minute schedule, the following layouts were considered:

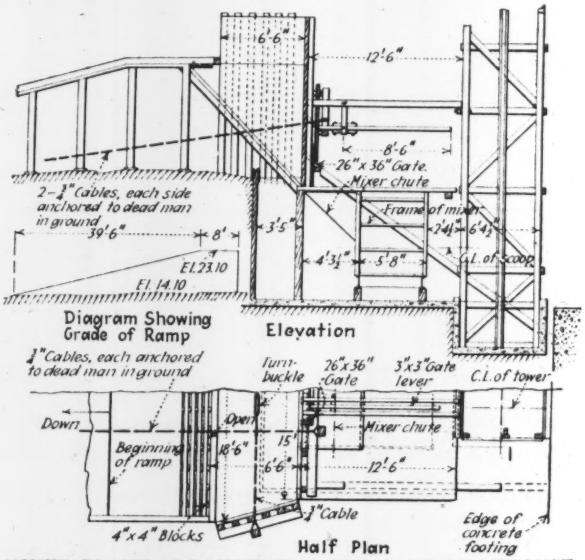
1. A double tower consisting of a combination hod hoist and bucket tower in the elevator shaft to take care of all concrete, brick, tile, etc., to the ninth story.

2. A mixer on the south side at grade, with elevated bins using a bucket conveyor, and a separate hod hoist on the west side from grade for hoisting materials for the setback portion.

3. A plant similar to layout 2 except that a separate tower for concrete was to be built from the fourth story to the ninth story roof level.

4. A mixer set below grade on the south side and a hod hoist tower from grade to the ninth story on the west side.

Layout 1 was eliminated, first because the speed



MIXER PLANT ARRANGEMENT FOR MACY WAREHOUSE

schedule called for the completion of two freight elevators with the finished building by Aug. 1, requiring the elevator workmen to have the shafts available by the middle of June; second, because this layout would make it necessary to build bins and a conveyor outside of the building line on a street congested with traffic, or inside the building, with expensive ramps, and with part of the first floor slabs and beams temporarily left out for head room.

Layout 2 was discarded when the cost of the power, motor, conveyor, etc., of this installation set against the cost of excavating for a mixer, and of erecting the short ramp required for layout 4, showed the latter to be far more economical. This layout would also necessitate the hoisting of concrete on a hod hoist for the upper stories and would interfere with the delivery of brick, tile and mortar to the masons.

Scheme 3 was abandoned when it was found that though it had some of the advantages of the second plan, it would interfere with the laying of the roofing at the fourth floor level and prevent making the roof tight. This layout would also require an additional hoisting engineer for the duration of the job.

Solution Adopted—Finally layout 4, with a very important change at a small increased cost, was decided upon. This change consisted in building, instead of a single hod hoist on the west side, a combination hod hoist and bucket tower with a ½-cu.yd. mixer set below grade. It was planned to use this half-yard mixer for concreting the tower section and for the 1-in. monolithic floor finish to the fourth floor level, thereby leaving the large plant free for continuous concreting during the entire day and eliminating subdivisions in the aggregate bin for sand, grit, screening, etc., used for floor finish. Premixed aggregate was used for concreting at the main plant.

The main plant consisted of a 1-cu.yd. mixer set about 9 ft. below grade with a concrete bucket pit. This arrangement placed the bin only 9 ft. above grade and made very easy to handle cement at the grade level from the storage pile to the mixer. The mixer was driven by a 25-hp. motor, and a double-drum hoist driven by a 40-hp. motor was used for raising the concrete bucket.

The aggregate was fed to a mixer hopper through a gate from the 35-cu.yd. storage bin. This was sufficient storage, as the "ready-mix" was delivered in 5-cu.yd. truckloads on approximately a five-minute schedule. These trucks dumped into the bin by backing up a planked ramp of approximately 20 per cent grade. A sketch of the layout of mixer, bins, etc., is shown.

The auxiliary plant on the west side consisted of a ½-cu.yd. mixer, hod hoist, double-drum hoist, two gasoline engines and a double tower with a single long cathead containing five sheaves. The mixer, set below grade, was fed by means of wheelbarrows and driven by a four-cylinder, 15-hp. gasoline engine. The other gas engine, 50 hp., was used to drive the double-drum hoist. This double-drum hoist equipped with a niggerhead was used to raise the concrete bucket, hod hoist, reinforcing steel and other necessary materials. During the concreting of the four-story main structure, the reinforcing steel and other materials were hoisted by using one of the drums and the sheaves of the hod hoist. Later, when the brickwork was started and the hod hoist used for raising brick, the reinforcing was raised by means of the additional sheave and the niggerhead.

Advantage of Plant Selected—The advantages of the plant were that: (a) Plant excavation was done by steam shovel while excavating for piledriving. (b) Cost of erection of hopper and bins and sheathing for mixer, using second-hand lumber, was $365 for labor. (c) Only three to four men were used at the mixer for charging and discharging and handling cement from the storage pile, depending upon the distance cement had to be handled. (d) The auxiliary plant allowed eight hours continuous pouring of concrete and starting monolithic finish shortly after 8 a.m. without interfering with operations at the main plant, and (e) allowed main floors of approximately 1,200 cu.yd. to be completed in 4 working days, all layouts contingent on using one set of forms.

Comparison of Costs—Increase in cost of layout used over proposed scheme 4, that is (installing auxiliary plant) versus the probable savings effected by installing it may be summarized as follows:

Increases—

1. Excavation for mixer—no additional cost, done by steam shovel.
2. Extra cost of double tower over single tower labor and material, using standard tower parts from storeyard, estimated at $200.
3. Rental and placing of engine and mixer estimated to cost, for a period of three months' use, $1,040.

Savings—

1. Time factor—Actual time saving was 1½ working days per floor on concreting main structure, plus an allowance of 2 days on brickwork due to elimination of interference with bricklayers on main structure, when concreting the tower or higher section, $1,888.
2. Plant rental and engineer's time—Another saving of this scheme over the other was that it allowed dismantling of central mixing plant when roof of main section was complete, saving plant rental and engineer's salary, which amounted in actual figures to $1,086.
3. Savings in cost of placing concrete

Estimated cost of concrete	$12,397
Actual cost of concrete	9,668
Saving	$2,729

4. Saving in placing finish

Estimated cost of finish	$6,850
Actual cost of finish	6,387
Saving	$463

Summary of Additional Costs and Savings:

	Additional Costs	Savings
Extra plant	$ 242	
Extra plant rental	1,040	
Time factor saving		$ 1,888
Plant rental saving		1,086
Placing concrete saving		2,729
Placing finish saving		453
	$1,282	$ 6,156
		1,282
Net saving		$ 5,874

Conclusions—In conclusion, our experiences on this and other jobs would lead us to believe that where there is a large yardage of concrete finish and brick and a time factor involved, the small additional cost of extra tower sides and bracing to hod hoist tower together with extra cost of auxiliary concrete plant, is more than paid back. We have found in the past that the major difficulties and delays in this type of work, using a single concrete tower and a single hoist tower, are:

1. Delays at concrete plant and changing over from rough concrete to pour top finish.
2. Delay in starting cement masons on floor finish with this plant layout.
3. Tendency on jobs to dismantle concrete plant before sills, coping, stairs, etc., are poured in order to save engineer's time, plant rental; and closing opening at floor hoppers for steel sash, etc., which makes it necessary either to hoist material dry before mixing by hand on the floor, or mix material below using bricklayers hoist for placing, thereby slowing up brick operation.
4. Lastly, the delivery of the building to the owners at a much later date, approximately one or two days per floor, than would be possible by the addition of the auxiliary concrete plant.

Does the New York State Barge Canal Pay?

An Analysis to Show that the Annual Savings to Shippers Using the Canal Will Soon Pass the Annual Costs to the State of the Canal

By Maurice W. Williams

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This analysis is presented as a comprehensive statement of one method of accounting on public works which presumably are built for community profit. It does not represent the view of "Engineering News-Record." Editorial comment appears on p. 408.—Editor.

For some time the opinion has been gaining ground that the Barge Canal, which has cost the people of the state of New York nearly $175,000,000, should never have been constructed. That opinion rests most largely on the fact that in no year has it ever carried much over 10 per cent of its nominal estimated capacity of 20,000,000 tons, and is most often arrived at without regard to other contributing factors.

The Barge Canal is not an enterprise from which direct returns can ever equal expense, nor was it intended to be such. It undoubtedly depresses freight rates on competing routes in the same territory and in adjoining territory, but such a comparison is objectionable to many. The data are insufficient to show the extent to which the Barge Canal has contributed to the prosperity of any given section of the country, although it is probably of considerable value in that direction. As a means of relief from traffic congestion within its territory, the canal has a real but indeterminate value.

There is one standard for judging the Barge Canal which is essentially fair and may be used to judge any waterway. This standard consists in the annual savings in rates on freight actually transported, as contrasted with annual costs of operating the canal. If the aggregate savings on freight actually shipped by canal equal or exceed the aggregate charges, then the canal may be said to pay. Fortunately the data are available for applying such a test, although a number of approximations are necessary.

Annual Charges—The cost of the maintenance and operation of the Barge Canal in 1925 was $2,981,841.26. This item will be no greater when the canal is carrying its capacity than it is now, for it costs no more to lock through 500 barges a day than 50. The capital charge for the year may be taken to be $6,150,807.68, which is the average of appropriations for the purpose for the two fiscal years between July 1, 1924, and June 30, 1926, these amounts having been carefully calculated by the State Comptroller. The debt charge has been decreasing steadily and may be expected to decrease further. The average maturity period of the funded canal debt is somewhat less than 50 years while the weighted average life of the component parts of the canal is considerably more than that. The amortization of the canal debt is therefore on a sound basis.

On or about Jan. 7, 1925, there were 751 claims against the state for damage to water rights and privileges, appropriation of lands, and so on, the face amount of which was $23,892,472.62. In 1925 the Court of Claims awarded a total of $856,767.82 on 229 claims, the original face amount of which aggregated $3,983,135.44. If all of the 751 claims were settled at the deduced average of about $3,745 per claim they would bring some $2,810,000; if they were settled on the ratio of awards to face value claimed, they would bring about $5,150,000. Bearing in mind that the total sum named represents the chaff of some 20 years during which the more valid have been winnowed out, and that the claims paid in 1925 undoubtedly represent the most meritorious, the latter sum may safely be used as an outside figure for the value of claims outstanding as of Jan. 7, 1925. No large claims have been filed since then.

While in 1925 the expenditures for permanent betterments amounted to $1,092,051.52, there is no possible need for the annual expenditure of any such amount as that, although improvements chargeable to capital may be needed from time to time as have been necessary on the Suez and other important canals. Growth of traffic following the opening of the Welland Ship Canal and of the Port of Albany may necessitate the enlargement of the channel between Oswego and Troy to a depth of 15 feet and a minimum bottom width of 110 feet at a cost now estimated to be $16,906,000. At the rate of expenditure in 1925 this improvement would be consummated in less than 16 years and if carried by direct appropriation would not add to the annual capital charges. It is inconceivable that any such sum as this will be required annually for other betterments and for claims combined, and yet the amount expended in 1925 may be carried as an annual charge, as a measure of conservatism, for as long a period as the capital charge is carried, until say 1960. There would thus be provided funds for settling claims and for the Oswego-Troy enlargement as well as some $16,000,000 for other improvements,—an amount far beyond any possible need.

In 1925 the state received $359,936.91 income from Barge Canal property of all sorts, such as charges at the grain elevators, use of terminals, use of excess canal waters, and ice cutting privileges. This amount will remain nearly constant but will tend to increase due to the development and sale of electric power at the dams already constructed across various rivers.

Summarizing the above items of expense, of which two are fully adequate for future years but the third is clearly excessive in the long run, and deducting income, the following table is arrived at:

ESTIMATED MAXIMUM ANNUAL COST OF BARGE CANAL

Maintenance and operation	$2,981,841.26
Capital charge	6,150,807.68
Permanent betterments and claims	1,092,051.52
Gross cost	$10,224,700.46
Less receipts	359,936.91
Net cost	$9,864,763.55

So much for what the canal takes out of the pockets of the people of the state every year; what does it put back by way of savings on freight actually carried?

Annual Savings—The rates of canal carriers are not controlled by either the Public Service Commission or the Interstate Commerce Commission. Not all carriers file tariffs, and the tariffs which are filed relate chiefly to class rates. Rates are governed mostly by supply and demand, and this condition results in bargaining between shippers and carriers on large tonnage movements. Although shippers necessarily know what rates they pay on freight moving by canal, by no means all of them know exactly how much they save thereby. No public records are kept of savings or of rates by canal.

On the other hand many concerns know closely how much shipping by canal has profited them, and a number of these communicated their data to the Barge Canal Survey Commission during its hearings late in 1925 or subsequently. Rates are so much a matter of common knowledge that the New York Produce Exchange annually quotes averages on wheat and corn by months for the entire season. Every shipment by canal means a saving in cost of transporting that shipment, as only the pull of the lower rate will attract the freight to water, generally speaking.

In 1925 there were carried by the Barge Canal 566,669 tons of wheat, 18,133 tons of corn, 36,724 tons of oats, 43,610 tons of rye and 253,755 tons of barley, virtually all of which moved from Buffalo to New York. Average rates for the season are given as \$1.81½ per ton of wheat and \$1.82¾ for corn exclusive of handling charges at Buffalo. In default of precise information on rates for oats, rye and barley, they may safely be assigned the corn rate. The corresponding rail rate for the grains mentioned is \$2.70. The indicated saving is therefore \$0.88½ per ton on 566,669 tons and \$0.87¼ per ton on 352,222 tons, or a total of \$808,815.76.

Some Typical Savings—A company in Rochester received 4,881 tons of nitrate of soda by canal at a total net saving of \$2,223.28 compared with the estimated cost of transportation by the next least expensive route.

A manufacturing concern in Middleport received from New York 19,215 tons of crude sulphur at a saving of \$63,409.83. From this sum may properly be deducted the fixed charges on plant erected especially for handling the sulphur at a cost of \$35,000, say 10 per cent, of this sum or \$3,500. This leaves a total net saving of \$59,909.83, or nearly \$3.12 per ton. This factor may safely be applied to all of the sulphur moving by canal during the year, since the saving could hardly have been less. A net saving of \$554,564.36 on the entire 177,869 tons is therefore indicated.

The same concern received 1,128 tons of white arsenic at a saving of \$2,255.49.

About 11,000 tons of salt moved from Meyers to New York at a known saving of \$1.75 per ton, and about 11,000 tons to Niagara Falls at about \$0.40 per ton. Since the entire movement of salt occurred in conditions generally similar, the saving on the entire 69,809 tons may be taken to be at the same average rate, giving a total of \$75,044.68.

A well-known Buffalo concern shipped 8,650 tons of oil cake to New York, saving thereby \$7,255.12 net after certain deductions to make the comparison fair. The same concern shipped 6,328 tons of flaxseed at a net saving of \$12,163.10. This rate may properly be assumed on the entire volume of 21,880 tons of flaxseed, since all of it undoubtedly moved in virtually the same conditions. The total indicated saving is therefore \$42,057.85.

A Syracuse lumber dealer saved \$4,000 on 2,000 tons of lumber coming from New York, both amounts being conservatively estimated, this tonnage having originated on the Pacific Coast and moved via the Panama Canal. The deduced saving may properly be applied to the entire 69,940 tons carried during the season, or \$139,880 in all.

The various items mentioned above may be summarized.

SAVINGS ON FREIGHT CHARGES ON THE BARGE CANAL IN 1925

Item	*Tons*	*Savings*
Grain	918,891	\$808,815.76
Nitrate of soda	4,881	2,223.28
Sulphur	177,859	554,564.36
White arsenic	1,128	2,255.49
Salt	69,809	75,044.68
Oil cake	8,650	7,255.12
Flaxseed	21,880	42,057.85
Lumber	69,940	139,880.00
Totals	1,273,038	\$1,632,096.54

Computed General Savings—The average saving on the items of freight enumerated above is \$1.28 per ton. Consideration of the classes of commodities comprising the 1,070,975 tons carried in 1925 but not appearing in the table, and the distances they were probably transported, leads to the belief that the unit saving averaged fully as much on them as on the commodities enumerated. The average rate on grain last year, however, was the lowest since the Barge Canal was opened in 1918, following a decrease which has been reasonably steady since then. On the other hand it would be unsound to use a rate averaged over any period back from 1925 because the decrease in grain rates corresponds closely to the increase in the size of cargo carriers, which has been 2½-fold within the 7-year period, and the barges are being built still larger. A rate on grain of \$2.00 per ton, corresponding to a saving of \$0.70 per ton instead of about \$0.88, is sustained by a plotted curve of grain rates for the past 8 years, and when the unit saving is applied to the above table an average of \$1.15 is given for the tonnage there shown. Applying this figure to the 2,344,013 tons carried during the season, the indicated total saving to shippers is \$2,695,614.95.

Two comparisons may be made to test the accuracy of the average savings per ton estimated above. One relates to operations by the Inland Waterways Corporation on the Mississippi and Warrior Rivers where conditions are fairly comparable with those on the Barge Canal. For a period prior to April 14, 1925, a saving was there made to the public of \$1,000,152.60, or nearly \$1.10 per ton, on 912,082 tons. For the 7 months ending July 31, 1925, shippers saved approximately \$880,000, or more than \$1.15 per ton, on 763,620 tons carried, while the corporation, after writing off depreciation, earned nearly 4 per cent on the investment in property and equipment. The weighted average of about \$1.12 is only \$0.03 per ton below the average used above for Barge Canal savings.

The other comparison relates to rail rates. While most of the freight moving via canal would take commodity rates by rail, the class of freight carried and therefore the rates would not vary widely from fifth

class. The carload rate from New York to Buffalo is $0.32 per hundredweight for fifth class freight. The prevailing canal differential in tariffs issued by navigation concerns is 20 per cent, making the saving to the shipper $0.064 per hundredweight or $1.28 per ton. It would be fair to apply the total saving only to freight moving the entire distance between the two points named, and to use some proportion of this figure for freight moving shorter distances. In default of published records showing individual movements but knowing that 62 per cent of the traffic for 1925 was classified as "through," it will not be far wrong for this purpose to apply the entire $1.28 to 62 per cent of the tonnage and three-quarters of that figure to the balance. The deduced average saving per ton is a little less than $1.16, or within about $0.01 of the average used.

Prospective Traffic—The net expense of the Barge Canal has been estimated above to be $9,864,763.55 annually until the average date of maturity of the bonds, beyond which there need be no capital charge or annual appropriation for betterments and claims, but only maintenance and operation. The net savings to shippers, the only direct benefit which under the constitution can accrue to the people of the state from the Barge Canal (except minor direct income), has been estimated to be $2,695,614.95. The difference between these two amounts, or $7,169,148.60, may fairly be said to represent the extent to which the canal did not pay directly last year. On the fair assumption that the saving per ton will remain fairly constant in future years, the answer to the question whether the canal will ever pay evidently depends on the future volume of traffic. The canal may properly be said to pay directly when annual savings on freight carried equal annual expense.

Since the opening of the Barge Canal in 1918 there has been a progressive increase in traffic in every year save one, and from 1918 to 1925 the average annual rate of increase over the preceding year has been very nearly 11 per cent. For the same period this compares with 12.7 per cent on the St. Lawrence Canals, 13.3 per cent for the Inland Waterways Corporation on the Mississippi and Warrior Rivers (since 1919), 9.2 per cent on the Manchester Ship Canal, 18.6 per cent on the Panama Canal, and 16.4 per cent in vessel tonnage on the Suez Canal, and a decline of 10.1 per cent on the Cape Cod Canal up to 1924. Gaged by traffic on waterways with which it may fairly be compared, the growth of traffic on the Barge Canal has been steady and normal. With Canadian grain moving freely through United States ports, with production of wheat per capita in the United States and Canada combined still increasing in the main, and with 12,000,000 tons of grain exported annually through Atlantic ports from Montreal to Norfolk, the tonnage of this commodity should continue to increase for many years to come. Other commodities now moving may also be expected to increase in volume, while a number of others ideally adapted for movement by water, like lumber and anthracite, have only just begun to make themselves felt.

Savings vs. Costs—Assuming that traffic continues to increase at the average rate of 10 per cent each year with reference to the preceding year, as now seems to be fully warranted, traffic will amount to 8,092,165 tons in 1938 and 8,901,382 tons in 1939, and at $1.15 per ton the savings will then be $9,305,989.75 and $10,236,589.30 respectively. In 1939 the canal will save to shippers more than the charges for that year and will therefrom be a paying enterprise in this sense. Traffic thereafter should continue to increase and the canal more than pay as measured by the excess of savings over charges. At the estimated rate of increase, traffic should reach the 20,000,000 tons nominal capacity of the canal in 1948, and thereafter the annual savings should exceed annual expense by some $13,000,000 per year until the need for annual appropriations for permanent betterments ceases, say 1950, when the excess of savings will be fully $14,000,000 per year until the average date of the amortization of the canal debt, now expected to be prior to 1960; after that time annual expense will consist only of maintenance and operation, and the savings will therefore be upward of $20,000,000 per year.

The one standard for judging the canal which is entirely fair and for which suitable data exist is that of savings on freight carried in comparison with expense. These now nearly equal the cost of maintenance and operation; within 13 years they may reasonably be expected to equal total annual expense; within 22 years they should exceed annual expense by some $13,000,000 per year; and within 34 years they should exceed annual expense by $20,000,000 per year.

Land Drainage and Flood Protection in Arkansas

WITH the new state administration in Arkansas, the removal of obstacles to important land drainage projects is hoped for. As the state is prohibited by its constitution from issuing bonds, the large mileage of improved roads that has been constructed during the past four years is being paid for by improvement taxes on the land, except for the comparatively small amount of federal aid. In consequence, the taxes on land have been raised so high that landowners feel they cannot afford more taxes, even where drainage improvements are needed. During the past three years, therefore, very little important drainage work has been started although some small projects are under way. Two years ago the governor blocked a move for reduction of taxes on farm lands, but at the recent election he was defeated by a large majority and a different policy is now expected.

A large reclamation project in which the United States government is concerned is that of drainage, flood control and protection from back water (in Mississippi River floods) along the St. Francis River. A survey and proposed plant was reported upon by F. H. Davis, United States assistant engineer, in 1922, but was returned for further investigation and pending action which was expected to be taken by local interests in Arkansas and Missouri. No such action has been taken as yet, and the report is being held awaiting final determination as to whether local co-operation may be obtained.

A preliminary report in 1925 to the St. Francis Levee District, of Arkansas, by H. N. Pharr, chief engineer, proposed the protection of 240,000 acres inundated by backwater by means of 53 miles of levee, with culverts, diversion canals and a pumping plant, with a total estimated cost of $4,246,168, or $17.70 per acre. Maintenance, operation and depreciation capitalized at 6 per cent amounted to $3,581,200, bringing the total cost of reclamation to $32.62 per acre. Under the Mississippi

River Flood Control Act, the Mississippi River Commission may pay 66 per cent of the cost of levee work, but in this project the levee is a comparatively small item, amounting to $7.75 per acre, so that the commission would pay only $5.17, leaving $27.45 per acre to be paid by the land owners. In view of this situation, the improvement is likely to be deferred for several years unless the United States Goverment can be persuaded to assist in providing equivalent drainage where the proposed levee would interfere with the present natural drainage and outlets.

Aerial Photographic Survey of International Waters

Advantages in Time, Cost, Detail and Accuracy in Mapping Rainy Lake District by Amphibian Plane

AN EXAMPLE of the use of aviation in engineering work is its application to the study of international waters in the Rainy Lake district on the boundary between the United States and Canada (in Minnesota and Ontario), where the aerial survey has expedited the progress of the investigations very materially. The following description of this work is from a paper by Lieutenant Ewart D. Plank, Corps of Engineers, U. S. A., read at the recent International Mid-Continent Architectural and Engineering Convention, held at Duluth, Minn.

As a protocol to the Lake of the Woods treaty between the United States and Canada, an agreement was reached for an investigation of the most advantageous uses of the boundary waters tributary to the Lake of the Woods, the desirability and practicability of storage, and the proper limits of storage, the work to be done jointly by the two governments under the International Joint Commission. The district engineer at Duluth, Minn., was designated as the engineer for the United States to the commission. The chain of lakes is about 175 miles long. Various sketches and maps of portions of these areas have been made. The commission had practically completed the mapping of a relatively narrow strip along the actual boundary, and advance sheets at a scale of 1:24,000 were available. The land adjacent to these lakes is heavily wooded except for such portions as have been cleared. Ready access may be had at a few points only.

It was apparent that one of the first steps was to prepare a topographic map including all the boundary lakes and such tributary lakes as might fall within the limits of possible storage. In view of the nature of the project, the character of the areas involved, the comparative inaccessibility of many portions of these areas, and in the anticipation of considerable saving in time and money, it was decided to obtain aerial photographs at a scale of 1:20,000 over the entire area as the initial step in the making of the map.

Due to the great abundance of lakes and the almost total absence of landing fields, a Loening amphibian observation plane was sent to Duluth by the U. S. Army Air Service. This plane was practically ideal for the project by virtue of the following characteristics: landings possible on either water or land; ceiling of approximately 15,000 ft.; cruising speed of 105 m.p.h.; high rate of climb for observation type of plane; gas capacity of 140 gal., sufficient for seven hours flying; excellent stability; good visibility for pilot; and ample room in rear cock-pit for installation and operation of camera and accessories.

The camera used has three lenses, three shutters, and three separate chambers. The optical axes of the side lenses make angles of 35 deg. with the optical axis of the center lens. The camera carries a single roll of film 6 in. wide and 190 ft. long, giving 190 exposures. Belonging to each camera is a transforming printer, so adjusted that the two oblique negatives from the side chambers of the camera may be projected to equivalent verticals and joined to contact prints from the center negative to form a composite vertical. This arrangement gives the camera tremendous covering power with its angular field of 114 deg.

Blueprints of the best available canoe route maps were mounted on heavy cardboard and marked with lines showing the courses over which it was planned to fly. In many cases a single flight covered all immediate areas desired, for the camera covers at a scale of 1:20,000 from 12,000 ft. altitude a width across the direction of flight of six miles. Over the larger lakes it was necessary to lay out parallel flight lines four miles apart, thus allowing for a side overlap of 33⅓ per cent between adjacent courses.

Due to the lateness of the season, it was believed impracticable to establish a base on any of the boundary lakes, because of the danger of the amphibian plane being frozen in. Accordingly a base was established in the Duluth-Superior harbor from which all photographic flights were conducted. This introduced an unusual obstacle, due to the distance of the base from the areas to be covered. The weather conditions at Duluth and at portions of the boundary lakes scheduled to be flown were frequently totally different. Several times, with a perfectly clear sky in Duluth the pilot and observer flew from 70 to 175 miles to some section of the work only to find the sky completely or partly overcast. Recourse was had to the co-operation of the U. S. Weather Bureau; from the weather maps it was possible to determine with surprising consistency when favorable conditions would occur along the boundary.

During these operations a total of 750 photographs were made covering a net area of 2,000 square miles. The photographs were taken with an overlap of 60 per cent in the direction of flight, and, where adjacent courses were laid parallel, with 33⅓ per cent lateral overlap. It is anticipated that the application of aerial photography to the preparation of this map will effect a saving of considerable time in completing the assignment, will effect a marked saving in cost, and will result in finer detail and a higher degree of accuracy than could otherwise have been obtained.

Fire Tests on Sheet-Steel Garages

Tests to determine the stability under fire conditions of all-steel garages and the hazard to adjacent buildings incident to a complete burning out of the contents recently completed at the Bureau of Standards demonstrated the ability of sheet steel to confine fire and reduce the hazard to neighboring property. The garage fired was an 18x18-ft. standard commercial structure with walls and roof of 24 gage galvanized sheet steel on a steel angle frame. The contents of the garage consisted of two passenger automobiles and about 1,000 lb. of other combustible material. Another garage placed 2 ft. away from the fired garage was unaffected by the heat and wooden walls 3 ft. away did not ignite for 30 min. The tests were conducted at the request of the Sheet Steel Trade Extension Committee, which constructed the garages for the tests. The following abstracted conclusions of the tests are taken from the last issue of the National Fire Protection Association Bulletin: "The interpretation of results depends on the assumptions relative to the degree of hazard with which a minor building such as a garage may expose a major building or another garage. If exposure of a degree that can be controlled with minor fire-fighting equipment or effort is to be permitted, it is apparent that the all-steel garage can be placed as close as 1 ft. from the lot line for all walls except the door sides, provided any windows in the wall next to the lot line or exposed building have fixed metal frames glazed with wire glass. Under the same conditions, an all-steel garage would be no hazard to a similar garage 2 ft. away."

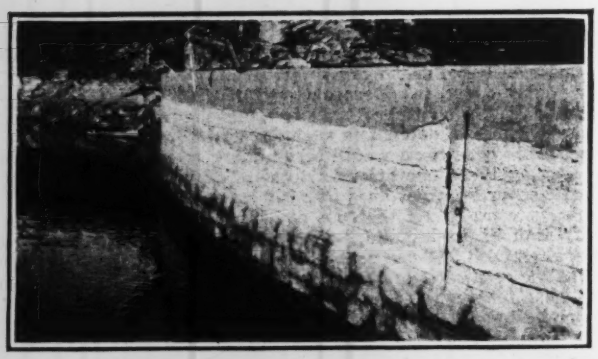
From Job and Office

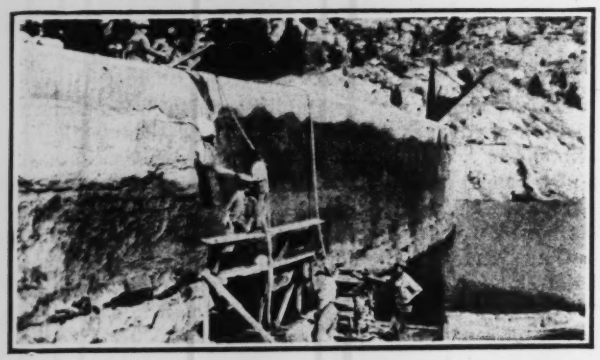
HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Guniting Upstream Face of Dam as Precaution Against Ice Damage

By Eugene Carroll
Vice-President and Manager, Butte, Mont., Water Co.

BASIN Creek Dam, impounding the water supply of Butte, was built originally of monolithic construction with a cut stone water face. In 1913, the dam was heightened by 13 ft. of reinforced concrete, the water face being plastered by hand. During the winter months the water in the reservoir is drawn down for consumption from 18 to 25 ft. below the crest of the dam, and ice forming on the surface is destructive to the plaster face and pointing of the masonry. This spring we replaced the defective plaster and repointed the joints with a cement gun.





REPAIRING WATER FACE OF BASIN CREEK DAM
Masonry joints pointed first with gunite. Below: Layout of construction equipment.

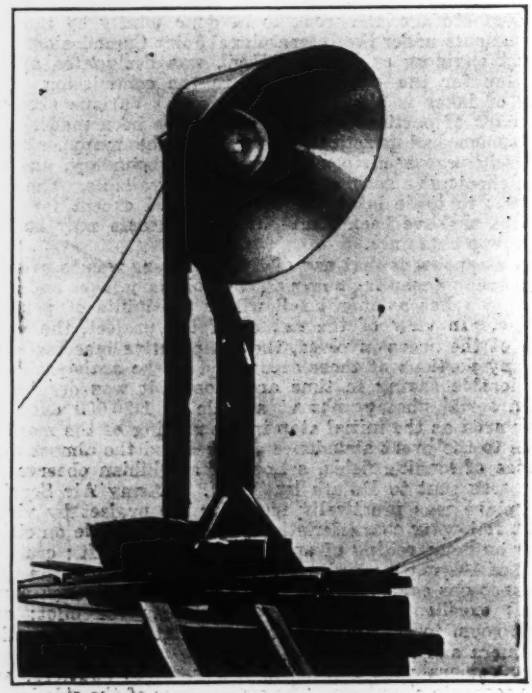
Men lowered from the top of the dam in boatswains' chairs removed all loose plaster and joints, using hammer and chisel. A raft was built of sufficient capacity to hold the cement gun and the necessary men to operate it. Water and air were supplied from an air compressor and small pump run by air located on top of the dam. The material was mixed in the proportion of two parts sand and one part cement at the west end of the dam, placed in cement sacks, and lowered onto the raft from the top of the dam. The joints and face of the concrete were thoroughly washed with a hose, and the gunite applied on the wet surface.

The joints of the masonry face were first pointed with gunite, after which three treatments were given the concrete surface, which gave an average thickness of about 1½ in. of cement. Over 4,500 sq.ft. of surface were treated by a force consisting of a foreman, three men operating the gun and eight helpers delivering material to the raft. It required fourteen days to complete the job. The finished surface is even and looks fully as well as if not better than the hand plastering which it replaces. From our experience with other structures, we believe the gunite to be less liable to injury from the ice.

Special Reflector Developed by N. Y. Contractor for Night Work

THE Foundation Co. has designed its own reflector for use on its construction jobs since the commercial ones are too small. The commercial lights, while throwing the light far enough, are too intense, becoming blinding to the workmen who have to face them.

The reflector used by The Foundation Co. is of 16-gage metal, riveted in the shape of a truncated cone, its base diameter being 48 in. The top diameter is about 8 in. Both white water paint and aluminum are used for the reflecting surface, but white water paint is considered the best. It may be washed repeatedly while aluminum collects dirt in such a way as to become gritty and impossible to clean.



REFLECTOR USED BY FOUNDATION CO.

One thousand-watt lights are used surrounded by a

frosted outer globe which diffuses the light. A stock fixture is used.

These lights are usually placed every 50 ft. However, a set placement scheme cannot be devised because of the many unlooked for shadows. The usual process is to set up the lights in the best way decided upon by the electrician and then to move them so as to eliminate the worst shadows. The rule is to place the lights so that the beams cross. Lights should never be placed opposite each other. By having the beams cross, many shadows are eliminated.

The reflectors are made large so as to get just as much light close to the reflector as far away. Diffusing the light enables a workman to look directly at it without being blinded.

The lights are wired in multiple so that if one should burn out the rest of the circuit is undisturbed.

Sewage Flow Uninterrupted While New Sewer Is Built on Old Course

THE construction of the new 8th Ave. subway in New York City has necessitated a change in grade of one of the branch sewer lines leading under the 8th Ave. and by way of 39th and 40th St. to an interceptor on 11th Ave. The grade has been so changed that the new sewer at its outfall end is 15 ft. lower than the existing sewer, and at its connection with the 8th Ave. sewer 35 ft. below the grade of the existing sewer. This allows the subway structure to be built above the new sewer.

In building the new sewer, which is a 7-ft. 9-in. x 6-ft. 9-in. reinforced-concrete box section with a brick invert, the course of the old sewer was followed. The old sewer is a 5-ft. brick arch. Service on this line had to be maintained during construction so the process was as follows:

The first operation was uncovering the old sewer down to about a third of its periphery. A wooden platform then rested on the interior of the arch and the old sewer was uncovered. The platform was installed so that in uncovering the sewer none of the brick or excavated material got into the sewage. With the arch then partially uncovered, the old sewer was undercut, and the trench carried to the new grade.

Because it is necessary to keep this sewer in constant complete operation, sewage is bypassed from the old sewer to the new section by a 20-in. steel sluice pipe. The upper end of the sluice pipe is set pretty well up into the old arch and where the arch has been taken down entirely, a cofferdam of sand sacks is built. With the trench excavated horizontal sheeting is installed, held in place by T-irons. The brick invert is placed in the new section and the reinforced-concrete box sewer built up with a movable form which runs on a track on the invert. The movable form is a 30-ft. steel section and is stripped from the concrete about 48 hours after pouring, though no backfill is placed on the concrete before the expiration of 5 days.

The bypass pipe extends back into the new box section about 100 ft. and that part of the sewer bypassed (about 250 ft.) is punctured at proper points to receive house services. Sewage from house connections is diverted into the bypass pipe through these top holes by means of wooden sluice boxes.

The work is part of one of the subway contracts held by F. L. Cranford and C. H. Locher and is under the direct charge of Thomas M. Nagle, superintendent of construction.

Layout for Pouring Seat-Support System of Concrete Bowl

By Zara Witkin
Chief Engineer, Herbert M. Baruch Corporation, Los Angeles, Calif.

TOPOGRAPHIC considerations imposed unusual plant arrangement upon the Herbert M. Baruch Corporation in the construction of the Hollywood Bowl, but recently completed. The topography of the site was such that it was impossible to bring aggregates in over the top or sides of the bowl, so the handling of concreting materials for the seat support system was done entirely from a single set-up on the stage, as is indicated in the sketch herewith.

The bowl is a natural amphitheater, consisting of concrete seat supports of radial stringers and circumferential beams. Beams and stringers are anchored into the hillside with columns running several feet into the ground. On this concrete seat support system are placed the wood seats which are fastened to bolts grouted in

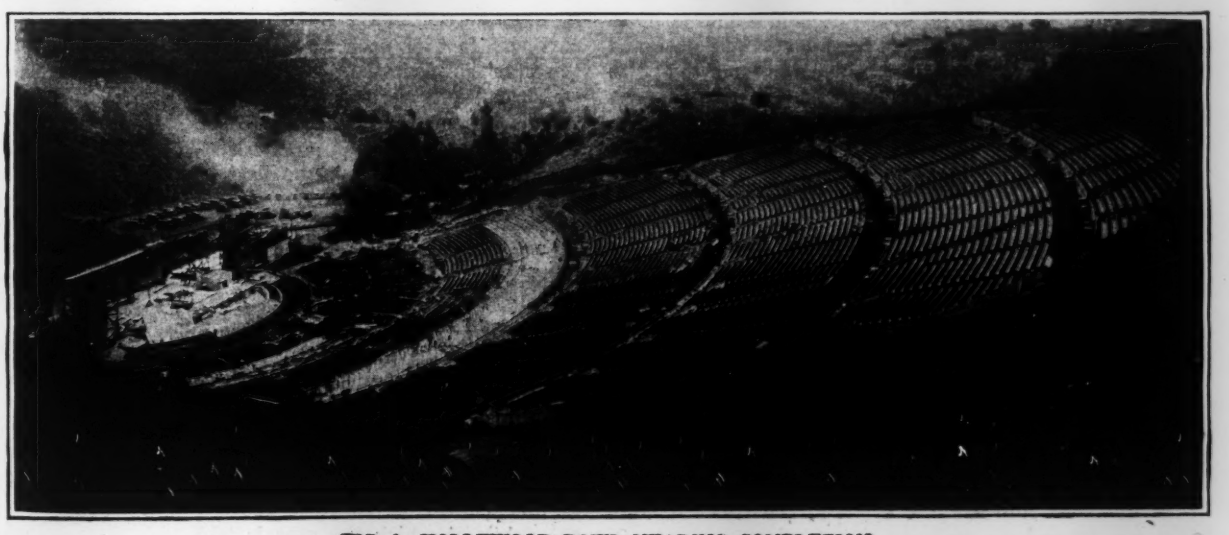


FIG. 1—HOLLYWOOD BOWL NEARING COMPLETION

the stringer seat blocks. There are wide stair aisles and protecting aisle walls at the bottom of each of the six banks of seats. A perimeter wall runs around the entire seat structure.

The project was rather difficult owing to a number of considerations. First, it was a short-time job. The work was commenced on March 20 and completed June 15. In the second place, concreting was widespread. The approximate axial dimensions are 450 ft. and 600 ft. Finally, an unparalleled rainstorm, in which the precipitation in a few days exceeded that of any of several previous years, converted the scene of operations into a sea of mud for a period of two weeks.

However, the significant feature of the work from a construction standpoint was the manner in which the concrete mixing and placing plant was designed and operated. A narrow-gage light industrial railway track

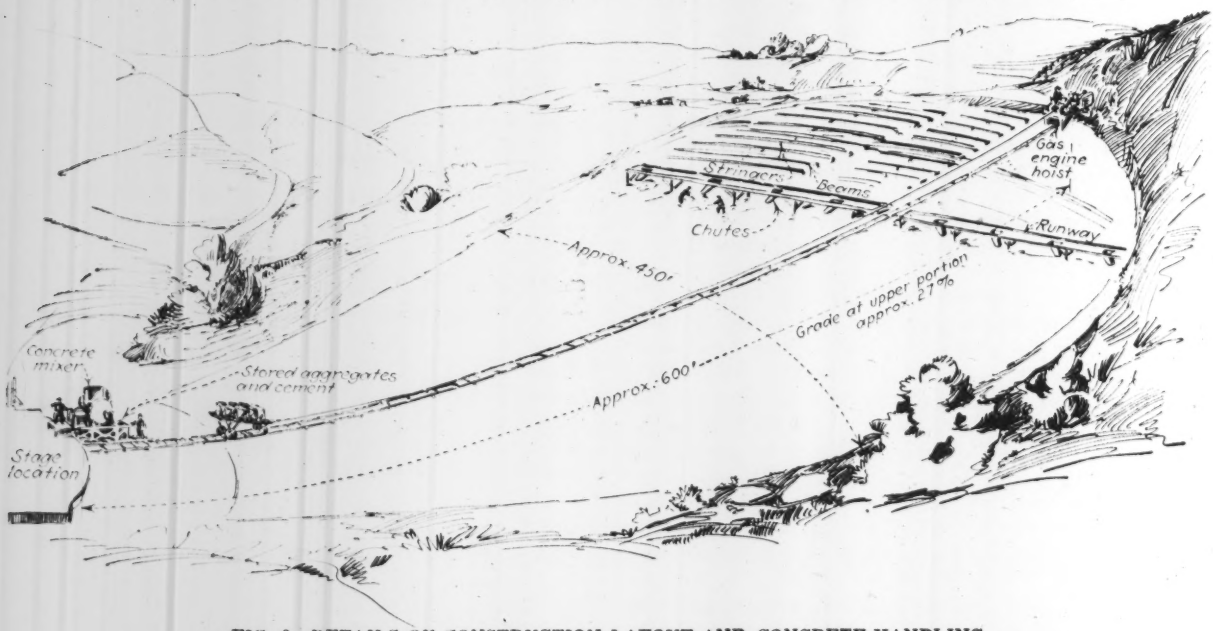


FIG. 2—DETAILS OF CONSTRUCTION LAYOUT AND CONCRETE HANDLING

was placed on steel ties on the center line of the bowl, leading practically from the stage to the upper rim of the bowl, at which latter point a gas engine hoist was installed. On this railway track a specially designed car was arranged to run, drawn by cable from the hoist and having its two upper wheels smaller than the two lower wheels so that the car body would remain practically level on the slope of the center line when the car was being hauled up by the hoist.

Near the stage, at the bottom of the incline, a platform was built upon which the concrete mixer was installed, the platform being at a level equal to that of the body of the car when the car was stopped alongside. The car was loaded with three concrete buggies and hoisted along the center line to reach the various tiers of seat-support beams which were being poured. The top tiers of beams were poured first and the concreting carried down the slope towards the stage.

To pour each segment of circumferential beams a runway was installed also level and equal in height to the height of the car body. The car was stopped at each of these runways successively, the concrete buggies run off and the material deposited.

From Job and Office

HINTS THAT CUT COST AND TIME

Cost of Pipe Line Excavations

By A. T. Cushing
Consulting Engineer, Kansas City, Mo.

IN CONNECTION with the appraisal of industrial plants, the writer has found it necessary to inventory and appraise underground water and sewer pipes of all sizes laid at various depths. The method followed in arriving at the value of pipe in place has been as follows: by making use of available plant, construction records and costs, both those shown on the company's books and others; and by conversation with the engineer and any other employees who were with the company when the pipes were laid and observed the work. By examination of the facilities in the field the number of lineal feet of each size of pipe in each section of the plant is arrived at, also the depth below grade at which this pipe is laid.

This information is set up in the form of an inventory. To each item of pipe as listed in the inventory two prices are applied, the first covering the cost of the pipe f.o.b. cars at the site. This is called the material price. The second, or the labor price, covers the cost of unloading, storing, transporting to the exact point of use, excavating the trench, placing the pipe therein, making the joints in the pipe, backfilling the trench and testing the completed line.

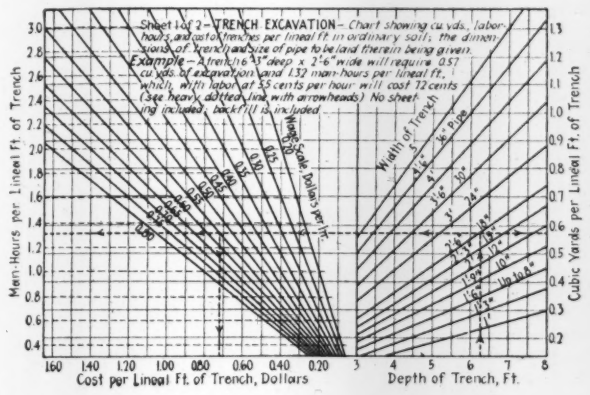
All of the above items except excavating and backfilling depend almost entirely on the size of pipe. While for large pipes the width of the trench varies with the size of pipe, for small pipes (say up to 12 in. in diameter) which will include probably 95 per cent of the items to be priced, the cost of the trench and backfill is independent of the size of pipe but depends upon the depth at which the pipe is laid.

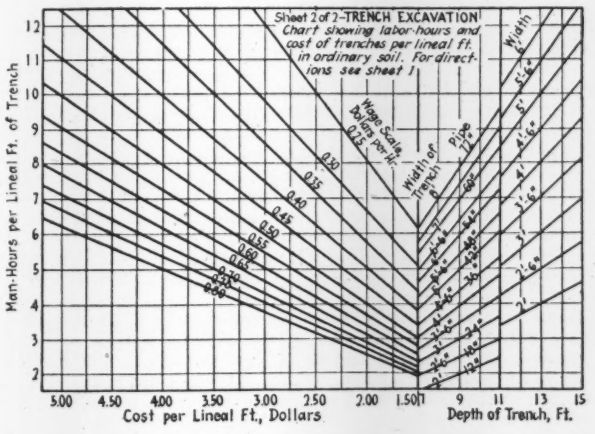
From Job and Office

FOR CONTRACTOR AND ENGINEER

It was with a view to developing a simple and quick method of arriving at the cost of trench and backfill for use as a part of the labor cost of laying pipe that the accompanying charts were developed.

As noted on Sheet 1 of the charts the prices obtained from these include backfilling but no sheeting and are for work in what is generally classed as dry ordinary


Sheet 1 of 2—TRENCH EXCAVATION—Chart showing cu. yds., labor-hours, and cost of trenches per lineal ft. in ordinary soil; the dimensions of trench and size of pipe to be laid therein being given.
Example—A trench 6'3" deep x 2'-6" wide will require 0.57 cu. yds. of excavation and 1.32 man-hours per lineal ft., which, with labor at 55 cents per hour will cost 72 cents (see heavy dotted line with arrowheads). No sheeting included, backfill is included
Man-Hours per Lineal Ft. of Trench
Cubic Yards per Lineal Ft. of Trench
Cost per Lineal Ft. of Trench, Dollars
Depth of Trench, Ft.
Wage Scale, Dollars per Hr.
Width of Trench
Pipe


Sheet 2 of 2—TRENCH EXCAVATION
Chart showing labor-hours and cost of trenches per lineal ft. in ordinary soil. For directions see sheet 1
Man-Hours per Lineal Ft. of Trench
Cost per Lineal Ft., Dollars
Depth of Trench, Ft.
Wage Scale Dollars per Hr.
Width of Trench
Pipe

GRAPHS GIVE PIPE LINE TRENCH EXCAVATION COSTS

soil. For material other than this the costs as obtained from the chart should be multiplied by the factors:

For dry sand.....	0.855	For wet ordinary soil	1.340
For dry hardpan or cemented gravel....	1.640	For wet hardpan or cemented gravel....	2.250
For wet sand.....	1.180	For solid rock.....	2.500

To the prices thus obtained should be added the cost of sheeting where it will be required.

The figures as obtained from this chart represent what the average laborer working under good supervision will do for 8 or 9 hours a day, and it is felt that estimates based on them will approximate very closely the actual cost of the work, provided the conditions are those for which the chart is made.

"Tar Scraper" on Marin Conduit Job Uses Waste Acetylene Gas

IN preparation for making the welded joint of a 26-in. steel pipe line laid for the Marin Municipal Water District, in California, considerable work was involved in clearing off the protective coating near the ends of the pipe sections. To expedite this work a "tar scraper"

THE "TAR SCRAPER" IN OPERATION

was developed which materially cut the time and cost of the work.

The scraper consisted of a piece of ⅛-in. copper plate about 3½ in. square, to three edges of which strips of hard steel with beveled edges were brazed. The side on which no cutting edge was attached was curved to form a connection to one end of a brass tube, through which gas was conveyed to one side of the copper plate. A handle of wood encircled the tubing, which was about 14 in. long, and at the rear end of the tubing was provided an ordinary welding torch valve and hose connection. The tube was connected with a low pressure acetylene gas supply; that is, to a drum in which the pressure had been drawn down below that considered satisfactory for welding.

With the gas ignited, the scraper was placed flat wise against the tar to be removed, with the flame between tar and scraper. After a few seconds in this position the tar would be softened so the scraper could readily be slipped beneath it and along the pipe. Once started, the flame spreading out over the copper plate and ahead of it, the tar was heated so that the scraper could be steadily advanced, raising up and cutting off the heated tar as it progressed.

Copper was used as a better conductor than steel, though if the device is to be used by an inexperienced operator an all-steel scraper is preferable because then there is no brazing that may be melted off by overheating.

The device was developed by Hugh F. Brown, of Brown Brothers Welding Co., which company holds this welding contract.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

Corrosion-Fatigue a Possible Cause of Embrittlement

Sir—In your issue of Aug. 26, p. 352, is a letter from Frank C. Boes on "Embrittlement of Steel and Copper." The "embrittlement" of steel turbine blades and copper wire described in his letter could be due to simultaneous action of a repeated stress range and corrosion. The writer has discussed the subject of corrosion-fatigue of metals in two recent papers ("Stress-Strain-Cycle Relationship, and Corrosion-Fatigue of Metals," American Society for Testing Materials, 1926 meeting; and "Corrosion-Fatigue of Metals as Affected by Chemical Composition, Heat-Treatment and Cold Working," American Society of Steel Treaters, 1926 meeting).

All the conditions for "corrosion-fatigue" of turbine blades are present in ordinary use. The copper wire also was probably subjected to a stress range, though this is not stated in Mr. Boes' letter.

"Corrosion-fatigue" does not cause change of grain size or structure. Reports of such changes in grain structure after fatigue or corrosion-fatigue have always been found to be based on misunderstanding of observations. There was probably no actual change of grain size in the copper wire.

D. J. McADAM, Jr.,
Metallurgist, U. S. Naval Engineering Experiment Station.

Annapolis, Md.,
Aug. 31, 1926.

More Information on Flying Ants

Sir—We note with interest your article on p. 267 of the Aug. 2, 1926, issue in regard to "flying ants." You will doubtless be interested to learn that the termite-proof building near Ancon has been completed but that our plans were slightly changed in regard to placing this building on concrete pillars. This was not due to a belief that such pillars would not be effective but, with the idea of having an all-wood building. Posts impregnated with coal tar creosote have been substituted.

In our suggestions in modifying city building codes to prevent termite damage, we have included a statement regarding the avoidance of the use of lime mortar in brick or stone wall foundations below the surface of the ground: "Where mortar is used in foundations or in cellar walls which are in contact with earth, in locations where termites abound, it should be composed of one part portland cement to three parts of sand graded from fine to coarse, with no grains greater than the No. 10 sieve, to which may be added ten per cent by weight of the cement of some workable agent such as hydrated lime. In preparing such mortar with quicklime, precaution should be taken that the lime is carefully slaked and screened, and after cooling is thoroughly mixed with measured quantities of clean building sand free from organic impurities. All mortar joints, the central one in particular, should be thoroughly filled. Or for greater precaution all brickwork extending below the surface of the ground should be faced and capped with concrete at least 1 in. thick."

It has not yet been established whether in the United States termites dissolve lime mortar by means of an acidulous secretion and gain entrance through lime mortar which has been disintegrated by soil bacteria, carbon dioxide gas in solution, improper slaking, or screening, or by mortar joints not being filled, particularly the central one. However, reports of contractors and builders and analyses of mortar samples where termites have penetrated between bricks in the United States have revealed these mortars to be lime mortars and not cement mortars.

In this connection you will be interested to learn that the National Lime Association, in consultation with this office, has built 16 brick or concrete foundation walls at our field station at Falls Church, Va. Six of the walls were poured of 1:2:4 concrete with a lime content varying from 0 to 40 per cent by weight of cement. Ten brick walls were built using 1:3 mortar by volume, varying the cementitious material from 100 per cent cement to 100 per cent lime. All materials were bought on the local market and the work was done by local labor. Lime putty made from lump lime was used, freshly slaked and also after aging for seven days. All mortar joints were filled. These walls were baited with timbers partially embedded in the top of each wall. Boards were also completely buried in the mortar about two-thirds up from the ground in each wall. These test walls were started about 8 in. below the ground and carried up to a height of 24 in. above the ground. Logs infested with termites were placed in the vicinity.

In commenting on these tests the U. S. Bureau of Standards suggests that they be broadened to include lime mortars gaged with portland cement. Also that specimens employing hydrated lime as well as quicklime putty be employed. The question of the properties of the secretion of the termites brings up the possibilities of the solvent effect of these materials on magnesium limes as well as high calcium limes. These suggestions will be carried out especially where the tests are conducted in the tropics.

T. E. SNYDER.
Entomologist, Bureau of Entomology,
Washington, D. C., Department of Agriculture.
Sept. 1, 1926.

Chlorination Studies Being Continued at Schenectady, New York

Sir—The extensive chlorination studies carried out last summer at the sewage-works of Schenectady, N. Y., described in *Engineering News-Record*, June 10, 1926, p. 943, are being continued on a larger and more practical scale this summer, with the hope of establishing conclusively the findings of last year.

Last year's study indicated that heavy chlorination of tank effluent prior to filtration had no permanent effect on the efficiency of nitrification of the beds, and at the same time reduced odors, surface pooling and apparently produced a decrease in the number of psychoda present in the treated beds. The study was carried out on but one-third of the total bed area, thus making odor and fly observations difficult and uncertain. The rate of chlorine application was constantly varied in order to observe the incident effects on the beds and no attempts were made to establish the most economical rate at which similar results could be obtained. It remains for the new study to determine whether chlorination on an economical basis will be a possibility.

The purpose of the study is the use of liquid chlorine to control odors about the entire plant and to control psychoda in and about the trickling filters.

During the spring of 1926, a preliminary study was carried out to determine the effect of chlorination of raw sewage, prior to treatment in the Imhoff tanks, on the tanks themselves and upon odors. It was found that chlorination of the crude sewage at rates as low as 6 and 8 p.p.m. often gave slight excess chlorine indications in the effluent. The tanks took on a fresher appearance and there was a distinct absence of any hydrogen sulphide odors at the dosing tanks. These tanks are so constructed that the tank effluent, on entering them, spills over long weirs and splashes turbulently over steps. A slight chloro-substitution product odor was noticeable at this point despite the fact that but one tank was receiving prechlorinated sewage.

As a result of this study, it was decided that chlorination for the control of filter odors could be carried out as economically—if not more so—at the inlet to the tanks than at the effluent end. The Chlorine Institute obtained another chlorinator from the Wallace & Tiernan Co. and installed it in another shelter at the inlet to the second battery of three Imhoff tanks. Sufficient capacity was thus obtained to chlorinate the entire sewage flow of 9 m.g.d. at a rate of 6 p.p.m., it having been decided that such rate of application would be economically feasible.

To date indications are that prechlorination destroys odors from the surface of the tanks, from the dosing tanks and from the spray thrown by the filter nozzles. There is a marked reduction in the hydrogen sulphide content of the tank liquor and the dissolved oxygen of prechlorinated tank effluent is about double that of unchlorinated tank effluent.

Odor control data will be accumulated during the entire run.

Psychoda control with liquid chlorine was attempted on the basis of the results of last year's work. It was decided that the removal of all the surface film from the entire three acres of beds by means of excess chlorination would result in a reduction of psychoda, which reduction could be continued by periodic dosing of the filters to prevent the formation of new gelatin on the stone surface. Bypass arrangements were provided by which the liquid chlorine could be delivered to the dosing tanks instead of to the raw sewage channels. Each filter was given 48 hr. of chlorination at rates of from 20 to 30 p.p.m., which resulted in the elimination of practically all of the surface film. The flies deserted the beds and in a few days an improvement in flies was noted. To date, but one other chlorination period was provided for psychoda control, at which time the treatment was continued for 24 hr. Psychoda have been under excellent control despite the sultry weather experienced during the last three weeks, and at present psychoda are visible in slight numbers only on the calm, muggy days.

Dichlorbenzene mixture is being applied to the gallery walls in conjunction with liquid chlorine-control work and is proving as effective as it did last year. This was especially noticeable on the days when the flies deserted the chlorinated beds and perched on the vertical walls of the galleries.

MORRIS M. COHN,
Superintendent Sewage Disposal.

Schenectady, N. Y.,
Aug. 20, 1926.

Theoretical Energy Losses in Intersecting Pipe Lines

Sir—The article by J. C. Stevens on "Theoretical Energy Losses in Intersecting Pipe Lines" in *Engineering News-Record* of July 22, p. 140, renders a useful service by directing attention to this neglected problem of hydraulics, but careful study of the article suggests various doubts as to the general reliability of the proposed formulas. The agreement of these formulas with the available experimental evidence is not uniformly good. In the ordinary textbooks experimental results are given for three special cases coming under this analysis. These three are: sudden expansion, sudden contraction, and abrupt bends in pipes. The proposed formulas check the experiments on the first of these with fair approximation, but on the second and third they do not check at all.

In the derivation of these formulas, criticism can be made of the use of the fundamental assumption: "Whenever two pipes join, the pressure at the junction is equal." This same assumption was formerly used in the attempt to derive formulas for the action of the hydraulic ejector, but it has been shown that they give results grossly at variance with those of actual experiments. The indeterminate nature of the assumption may be seen by wording its statement as follows: "Within a greater or less distance downstream from the junction of two pipes the pressures in all parts of the cross-section will become equalized, *but a portion of the energy loss or exchange may take place before this point is reached.*" The reservation in the last clause destroys the value of the assumption for purposes of exact analysis.

A serious objection to the proposed formulas is that they give the same loss of head if the direction of flow is reversed. This contradicts the commonly observed fact that losses due to eddying and turbulence are greater when the stream lines are diverging than when they are converging.

Experiments on energy losses in intersecting pipes are greatly to be desired. Before these are available it would seem best to use the theoretical formulas with a good deal of caution.

HAROLD A. THOMAS,
Associate Professor of Civil Engineering,
Carnegie Institute of Technology.

Pittsburgh, Pa.
July 28, 1926.

Sir—Prof. Thomas has raised a perplexing question. Where is the intersection of the two streams, and what is the pressure at their junction?

In my article, I was careful to point out that I was dealing with mean velocities only, since to attempt otherwise involves complexities that are almost unsurmountable.

At the junction the water is in a swirl and pressures are variable throughout the section. Yet there must be some value that represents the junction pressure. Whatever this pressure is, is designated by J in the article in question. It is not the pressure at some distance downstream where the pressures in all parts of the cross-section have been equalized. If the author's formulas are wrong, then Newton's law of motion are wrong. If the results do not agree with the experiment the fault is not in the formulas, as fundamental starting points, but in the inability of the experimenter to evaluate the quantities involved in them.

Consider the three special cases mentioned by Prof. Thomas. As he states, experiments on sudden expansion agree fairly well with the formula, but there is a divergence due, first, to the error of using mean velocities instead of the integral of particle velocities, and second, to the impossibility of measuring pressures accurately, particularly in the plane of the enlargement. The only experiments of which I am aware are those of W. H. Archer mentioned in the article, yet these leave much to be desired.

The experiments on sudden contractions are very limited and incomplete. The formulas heretofore developed are based almost entirely upon the contracted area of the jet and its subsequent expansion to fill the smaller pipe. The eddies that occur in the corners of the larger pipe at the plane of contraction appear to have been neglected. It is true that experiments so far made show losses considerably less than called for by my formula 8. Every hydraulic formula involves empirical coefficients. It is entirely logical to express the loss in a sudden contraction or enlargement by a formula,

$$i = C \frac{(v - V)^2}{2g},$$

where the coefficient C is to be determined experimentally, and will have different values depending upon the direction of flow.

Experiment has proven conclusively that velocities may be increased without eddy losses, but that they cannot be diminished without involving some eddy loss. So far as the momentum and energy equations applied to mean velocities and average pressures in the cross-section are concerned, there is no distinction between increasing and diminishing velocities. Actually, there is a distinction which leads us to believe that the application of these principles to mean velocities is insufficient. We must apply them to particle velocities to secure results that check experimental data. This, however, is well nigh impossible. The only alternative is the use of empirical coefficients and the determination of the law of their variation with pipe sizes and velocities.

As to right-angle pipe bends, we are also practically without experimental data to test the validity of my formulas. Standard T's have some curvature and yet experiments show that the energy loss is from 1¼ to 1½ times the velocity head. My formula states that the loss should be *twice* the velocity head in a strictly right-angle bend. Since there is no change in velocity the drop in pressure is all used to supply the energy loss. The momentum, and hence the velocity in the original direction, is entirely destroyed and must be reproduced again in the new direction. Based on mean velocities, therefore, the formula is obviously correct fundamentally. That it requires empirical coefficients is also obvious, since mean velocity is purely an imaginary thing.

The purpose of my paper was merely to show the fundamental relationship that exists among a group of hydraulic phenomena that have heretofore been considered as separate and distinct problems. Once their fundamental relationship is established, the determination of empirical coefficients can be undertaken with far greater hope of success.

Prof. Thomas raises a "serious objection to the proposed formulas" because "they give the same loss of head if the direction of flow is reversed." I believe that fundamentally speaking this is a distinct advantage instead of an objection. Once we learn why diminishing velocities involve energy losses while increasing velocities do not, and the laws that govern this phenomenon, we are in a fair way to solve some of the hydraulic problems that are today quite baffling.

J. C. STEVENS,
Stevens & Koon, Consulting Engineers.

Portland, Ore.,
Aug. 19, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

WASHINGTON NOTES

THE Corps of Engineers will cooperate with the municipal authorities, the railroads and other private interests that are engaged in making a study of the settlement of the land along the bluff on the Tennessee side of the Mississippi River at Memphis following the landslide which occured there on July 25, reported in *Engineering News-Record* Aug. 5, 1926, p. 231.

REPRESENTATIVE DEMPSEY, of New York, is requesting the engineer board on the Lakes-to-Hudson deeper waterway to allow public hearings in connection with its studies as to the cost and feasibility of a 30-ft. channel. Mr. Dempsey wants to present witnesses who will attempt to establish that further rail development between the Lakes and New York City is impracticable.

The board after its organization meeting at Buffalo early in August, is busy co-ordinating such economic data as is available in the files of other government agencies. Another meeting of the board, of which General Herbert Deakyne is chairman, will be held early in September.

AN ADJUSTMENT of the boundaries of the Yosemite National Park so as to eliminate twelve acres from the Southwest corner of the reservation has been recommended by F. E. Bonner, district engineer at San Francisco for the Forest Service. This change is regarded as desirable so as to permit the development of the power resources of the South Fork of the Merced River. A dam 330 ft. high will make possible the development of 33,800 hp. of primary power but the reservoir essential to the development inundates an obscure corner of the park without any claim to scenic beauty.

An application covering the project has been filed by the San Joaquin Light & Power Corporation.

THE FEDERAL Power Commission at its meeting Aug. 19, agreed to extend by ninety days the period in which the Susquehanna Power Co. and the Philadelphia Electric Co. may have for the submission of the pre-license cost of the Susquehanna project. Unavoidable delays have occurred in the obtaining of the necessary information as to certain expenditures, obligations and liabilities incurred by or on behalf of the licensees prior to the date of the license. The Public Service Commissions of Maryland and Pennsylvania are agreeable to this extension.

Engineering Fifty Years Ago

From *Engineering News*, September, 1876

PROFESSOR GRAHAM BELL has succeeded in transmitting the tones of the human voice by telegraph. The apparatus is similar to the thread telegraph, a toy consisting of two small tin or wooden cylinders, each having a membrane stretched over one end, the two membranes being connected by a stout thread. In the telegraphic instruments the membranes of gold beater's skin are provided with proper vibrating armatures, connected with the wire. Vowel sounds are transmitted with remarkable accuracy. The consonants are somewhat indistinct, but still, it is said, the sentences can be quite readily understood. Musical sounds are accurately reproduced. This invention in connection with that of Professor Gray, by which several messages may be sent over the same wire in both directions at the same time, by means of vibrating armatures tuned, as you might say, to a certain pitch so that each receiver picks out its own message, marks an epoch in modern telegraphic invention.

The commission authorized the issuance of a preliminary permit to the Twin City Power Co. and to another corporation known as the Twin City Power Company of Georgia, covering a proposed project on the Savannah River at Price's Island in McCormick County, S. C., and in Lincoln County, Ga. Plans provide for the construction of a 70-ft. dam across the river at the lower end of Price's Island. This will back water upstream for a distance of 22 miles. The primary power which thus will be made available is 30,000 hp. The applicants propose to install equipment sufficient to develop 65,000 hp. The river has been improved for navigation, but the Chief of Engineers has approved the project provided the interests of navigation are properly safeguarded.

A preliminary permit also was authorized for the Lexington Water Power Co. at Columbia, S. C., covering a project in the Saluda River in Lexington, Newberry, and Saluda Counties, S. C. It is proposed to construct a dam 93 ft. high and a power house to contain four 12,000 hp. units. The Chief of Engineers has approved the project.

A license also was authorized for the Kent Hydro Electric Company at Dam No. 7 on the Kentucky River.

F. E. Winsor Appointed Engineer for New Boston Water Supply

Frank E. Winsor, chief engineer of the nearly completed additional water supply works for Providence, R. I., has accepted the position of chief engineer of the recently created special construction commission to provide an additional water supply for the Boston Metropolitan District from the Ware and Swift Rivers. Before taking up the Providence work, in 1915, Mr. Winsor had been one of the engineers on the Catskill aqueduct, New York City, and before that had been on the engineering staffs of the Massachusetts Metropolitan Water and Sewerage Commissions, and the Charles River Basin Commission, which built the dam between Boston and Cambridge. Mr. Winsor's salary in his new position is reported as $13,500 a year. The Massachusetts' statute creating the new construction commission named above was abstracted at length in our issue of June 9, 1926, p. 934.

General Contractors Board to Meet at Kansas City

The fall meeting of the Executive Board, the Advisory Board, the President's Council, and Secretary's Council of the Associated General Contractors of America is to be held at Kansas City, Oct. 4-8, 1926. The first and third days will be devoted to general sessions and the fourth day to the Secretary's Council. On the second day sessions will be held for the consideration of problems particularly connected with state highway construction.

It is planned that members attending these sessions will be formed into groups and will travel to the sessions following definite itineraries, visiting centers where there is considerable construction activity.

Georgia & Florida Ry. Making Plans for New Line

Receivers for the George & Florida Ry., as part of their plan for the reorganization of the company, will ask the Interstate Commerce Commission for authority to construct a new line from Augusta, Ga., to Greenwood, S. C., a distance of approximately 56 miles. The new line with the Piedmont & Northern, an electric line, will give the railway a connection with the Carolina, Clinchfield & Ohio to form a new north and south route.

The plan of financial reorganization provides for raising between $5,000,000 and $6,000,000 of new funds, of which about $3,500,000 would be spent for the construction of this new railway and for new freight cars.

Bids for State Office Building to Be Called in December

It is expected that the plans for the $10,000,000 state office building to be built by the State of New York at Albany will be ready so that bids can be called for by December 1. After bids have been received, the legislature will be asked to authorize the sale of bonds and make an appropriation for the cost of construction.

Sub-surface exploration of the site indicates that the rock lies from 160 to 200 ft. below the surface.

Contract Let for Third Section of Boston Subway Extension

Contract for the third section of the Dorchester Rapid Transit, Boston, Mass., has been let to the C. & R. Construction Co. for $626,550. Contracts for Sections 1 and 2 were let about this time last year.

The third section is a double-track portion of the rapid transit system about one mile in length, of which about 4,000 ft. is to be covered, the tracks being depressed in order to abolish grade crossings at five streets. The work consists of the construction of the roadbed, reconstruction of sewers, sewer siphons, and removal of structures. The covered portion is to be built of steel and reinforced concrete and will include a side platform station.

Advice on Completing Indianapolis Sewage-Works Recommended

Employment of one or more consulting engineers on bringing the Indianapolis sewage-works up to needed capacity is recommended by the Committee on Sewage Disposal of the Indianapolis Engineering Society in a report to the society dated Sept. 1 and approved at a regular meeting of the society held Sept. 2. The members of the committee are William Higburg, chairman, E. L. Goldsmith, and Daniel B. Luten, secretary. The report, in substance, reads:

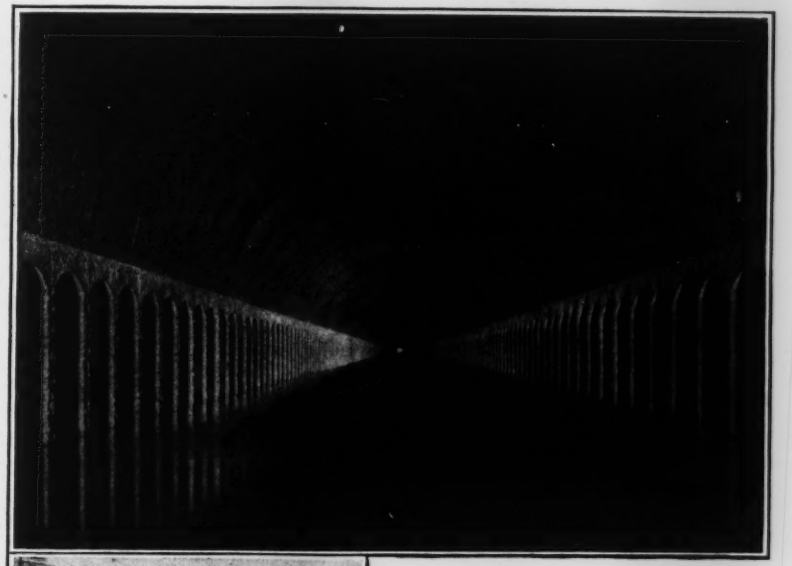
"The records of the Board of Sanitary Commissioners show that all of the dry-weather flow of sewage of the Sanitary District is being handled by the screening devices, but the aeration and settling equipment, when operated at their maximum efficiency and under most favorable chemical and physical conditions of the sewage, cannot handle more than 75 per cent of the designed capacity of the plant. The plant is properly purifying only two-thirds of the present dry-weather flow of sewage of the district and the remaining one-third is being discharged into the river after having only a mechanical treatment. We are confronted with a dry-weather flow that approximates the 50 m.g.d. estimated for 1930.

"The plant design calls for disposal of sludge by drying and marketing it as fertilizer. Some $200,000 have been spent on the purchasing and housing of this drying equipment but it has not yet been placed in operation, even in an experimental way. The sludge is now pumped into lagoons. Apparently, in a relatively short time no space for sludge storage will be available. The problem of sludge dehydration is admittedly a difficult one due to the high water content of the material. A solution of this particular problem goes hand in hand with successful operation of the plant and so needs the application of effort to bring about a speedy solution. There appear to be other technical problems relating to this plant that need study and solution but the major problems have been stated.

"The members of your committee realize the seriousness of the existing situation and the need of a competent solution. The Board of Sanitary Commissioners are undecided on the next logical step toward completion of the plant.

"Our decision and recommendation on this matter is that the Board of Sanitary Commissioners should employ an independent expert engineer, or if more than one engineer be employed, each enginer should bring in his individual report. It should be the duty of the engineer or engineers so employed, to make definite recommendations to the board for: Bringing the sewage disposal plant up to efficient operation at its designed capacity of 50 m.g.d.; for means and methods of satisfactory sludge disposal; and for effectively completing the plant in all its details; said recommendations to be accompanied by cost data both for changes or additions to the plant and for operation of the plant after such changes have been effected; the engineer whose report is acceptable to the Board to be employed to carry out his recommendations."

ROVE SHIP TUNNEL FOR MARSEILLES-RHONE CANAL COMPLETED



DELAYED by and nearly abandoned because of the war, the Rove tunnel, the last connecting link in the Marseilles-Rhone canal in France, has been completed as shown by the upper photograph. It is probably the largest tunnel in the world, a typical section being composed of a square invert 59 ft. wide and 15 ft. deep with a semicircular arch of 41-ft. radius. This gave an excavated section 79 ft. wide and 50 ft. high. The tunnel is 4½ miles long, passing through a mountain ridge north of the city whose geologic formation is marly limestone containing few faults and no subterranean streams of any size. The water depth is about 10 ft.

The completion of the tunnel will permit river traffic originating at Lyons and other interior points in France to pass from the Rhone River to Marseilles without making a dangerous 25-mile trip into Mediterranean waters to round the cape west of the city. The lower view gives an idea of the centering used in lining the tunnel. Articles describing this project have appeared in *Engineering News*, Aug. 26, 1915, p. 386; Oct. 21, 1925, p. 803; Nov. 30, 1916, p. 1013; and in *Engineering News-Record*, Nov. 25, 1920, p. 1046.

Chicago Bridge Work Is Active

Four bascule bridges are now under way at Chicago. On the Chicago River, the substructure has been completed and steel erection begun for the Adams Street bridge, replacing an old swing span, while the substructure is being built for a new or additional bridge at La Salle St., to relieve congestion on adjacent north and south streets. The contract for the superstructure has been let. In connection with the project for straightening the river between Polk and 18th Sts., the construction of a bridge over the new channel at Roosevelt Road may be begun this year. On the Calumet River, the substructure for the 100th St. bridge is completed and steel erection has begun. Work will be commenced soon on a bridge at 106th St., funds having been provided in a recent bond issue approved by the voters.

Reorganized Moffat Railroad to Finance New Cut-off

The final step in the financial reorganization of the Denver & Salt Lake Railroad Co. was taken recently when the receivers sold the property to a newly organized Denver & Salt Lake Railroad Co. for $3,750,000, the upset price fixed by the district court. This action was taken five years from the date of the appointing of receivers.

The new company has entered into an agreement to lease the Moffat tunnel upon its completion and it expects to raise funds for the construction of the Dotsero Cut-Off between the western end of its line and the Denver & Rio Grande Western R.R.

Progress on the tunnel up to Aug. 15 was as noted below, the length of work remaining being 3,254 ft. between the water or pioneer tunnel headings, 4,357 ft. between the main or railroad tunnel headings, and 10,111 ft. between the enlargements of the main tunnel to full section.

	East Ft.	West Ft.	Total Ft.	Per Cent Completed
Water tunnel headings	16,268	12,861	29,129	90.3
Railroad tunnel headings	15,858	12,078	27,896	86.5
Railroad tunnel, full size	13,852	8,290	22,142	68.5

Wisconsin-Iowa Bridge Project

A commission to consider the construction of an interstate bridge across the Mississippi River, authorized by the Iowa legislature in 1925, has held meetings to consider various projects and is giving special attention to that for a bridge between McGregor, Iowa, and Prairie du Chien, Wis. F. R. White chief engineer of the Iowa state highway department, is a member of the bridge commission. By arrangement between the two state departments, the Iowa department is making extensive studies of this crossing, and when the legislatures convene in 1927 the two highway departments will be in a position to present some definite information or recommendations.

Advisory Board Named for New Orleans Bridge

Contract drawings for the proposed Mississippi River crossing about six miles north of New Orleans are now being prepared.

The general layout of the bridge as approved by the War Department in June, 1925, consists of a central span, 790 ft., two anchor arms, each 530 ft. and two flanking spans at each side, 532 and 333 ft., respectively, center to center of piers, making a total length of main bridge of 3,580 ft. On account of the vertical clearance required (130 ft. above mean gulf level), the approaches will be approximately 1¾ miles long on each side of the river. The design provides for a double-track railway and two 18-ft. roadways carried on cantilever brackets outside of the trusses. From the results of test borings, it appears that the foundations of the main bridge will have to be carried not less than 150 ft. below mean gulf level. The details of these foundations have not as yet been decided upon, pending results of certain experiments which are now being conducted, on the bearing value of strata encountered at the proposed site.

The work is under the auspices of the Public Belt Railroad Commission of New Orleans. After the approval of the clearances by the War Department, Ralph Modjeski was appointed chief engineer of the project, and prepared the preliminary design. A board of advisory engineers, consisting of Daniel E. Moran and Howard C. Baird of New York City and A. F. Barclay of New Orleans was later appointed, and approved the preliminary plans. The contract drawings are now well under way.

River Regulating District Meets With Opposition in New York

Formation of the Salmon River Regulating District, a municipal corporation authorized under the conservation law of New York State, for the control of the flow of the Salmon River was opposed at the hearing before the New York State Water Control Commission held on Sept. 1. The opposition came from such organizations as the Association for the Protection of the Adirondacks and is based upon the claim that the formation of river regulating reservoirs will be detrimental to the region and that such reservoirs will be used more for the production of power than for the prevention of floods in the lower reaches of the river.

The hearing was adjourned until Oct. 5.

A World's Record for Drifting

In driving the new 8-mile Cascade tunnel for the Great Northern Ry. in the State of Washington, A. Guthrie & Co., the contractors, made what they believe to be a world's record for drifting. They progressed 937 ft. during the month of August, working one face only in a drift 8x9 ft. in cross-section. The company would like to know whether this record has ever been exceeded.

Flood Damages Illinois and Iowa

Heavy rainfall of a "cloudburst" character on Sept. 1 caused serious damages and flooding in the central part of Illinois, with roads, railroad tracks and highway bridges washed out and large areas of farm land under water. At Galesburg, the waterworks and electric light plants were out of commission for a time, but connection was made with the transmission line from the Keokuk hydro-electric plant. Some residence districts were isolated by the flood. The same storm caused flooding of land and damage to crops in Iowa.

World's Largest Steam-Electric Generators for California

Two steam-electric generators with a nominal rating of 90,000 kw. at 90 per cent power factor are being built for the Southern California Edison Company at the Schenectady plant of the General Electric Company. These generators are stated to be the world's largest in both capacity and physical dimensions, being larger than either the single 60,000 kw. unit being installed in the 14th St. plant of the New York Edison Co. or the 80,000 kw. compound unit in operation in the plant of the Brooklyn Edison Co. The turbines which will drive the generators are to be of the tandem-compound type with a rating of 94,000 kw. at 90 per cent power factor.

The largest pieces which will have to be shipped from Schenectady to the Pacific Coast, the revolving fields of the main generators, will weigh 230,000 pounds. The armatures, each weighing 330,000 lb., will be assembled at Los Angeles on account of the limitation on bridge loads and tunnel clearances on the railroads.

Four Power Dams to Be Subject of Hearing Before U. S. Engineers

A public hearing to consider applications for the construction of four power dams on the Holston and Watauga rivers in Tennessee is to be held before Major Fiske, the district engineer, Chattanooga district, at Johnson, Tenn. on September 10. The Tennessee Eastern Electric Co. has applied for authority to construct five dams but only four of them are to be considered at this time.

The dams to be considered are, a 110-ft. dam located just above Pactolus bridge on the south fork of the Holston River for the generation of 60,000 hp., a 90-ft. dam on the South Fork of the Holston River for the development of 25,000 hp., a 90-ft. dam on the Watauga River for the development of 25,000 hp., and a 130-ft. dam about four miles from Bluff City on the South Fork of the Holston River for the development of 30,000 hp.

The application for the construction of a 78-ft. dam on the Holston River between Marblehall and Galbraith Springs in Hawkins County together with the construction of a power canal for the development of 100,000 hp. will not be considered at this hearing.

Contractor Awarded Damages in Road Relocation Suit

United States District Judge Merrill E. Otis at St. Joseph, Mo., on Aug. 27 awarded the Coopers Construction Co. of Illinois $30,000 on its $300,000 claim against the Missouri State Highway Commission.

The Coopers company claim was based on the fact that the state highway department had altered routes of its roads in Southern Missouri thereby causing it losses from delay and deprivation of anticipated profits.

Judge Otis held the construction company was entitled to recover for losses from delays but not for anticipated profits.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., Oct. 11-14, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

The North Atlantic Section, American Society of Agricultural Engineers, will meet at Pennsylvania State College, Oct. 11-13. **The Southwestern Section** of the Society will hold its meeting at Dallas, Texas, Oct. 8, 1926.

Personal Notes

HERBERT C. KEITH, consulting engineer, has opened an office in New Haven, Conn., at 78 Center St., while still retaining his office at 15 Park Row, New York City; his practice is on structures, transportation, city planning, and legal matters connected with engineering.

CHARLES C. JORDAN has been appointed district engineer of the Birmingham, Ala., office of the Portland Cement Association, going there from the Nashville office. Mr. Jordan had previously been an assistant engineer on construction work along the Warrior River, assistant city engineer of Havana, Cuba, and construction engineer on paving in the South. During the War he served as captain of engineers in the Rainbow Division.

E. J. CLOHESSY, of Syracuse, N. Y., has been appointed city engineer of Olean, N. Y. Mr. Clohessy was previously engineer in Seneca County, New York, on state work.

L. W. MAHONE, instructor in civil engineering at Iowa State College for the past five years, has resigned to enter into private practice in engineering and surveying, with offices at Ames, Iowa.

FRANK WHITE of Providence, R. I., has been elected president of the J. S. Packard Dredging Co. to succeed FRANK HEALY, who died recently. Mr. White has been general manager and superintendent of the company since 1905. For 35 years he has been active in harbor and river improvement on the Atlantic coast, from Maine to Florida.

A. T. LUCE, recently superintendent of water-works, Marshalltown, Iowa, has joined the staff of the Federal Water Service Corporation, New York City. H. V. PEDERSON, former state sanitary engineer, in Iowa, succeeds Mr. Luce at the Marshalltown Waterworks.

WALTER L. DRAEGER, engineer, employed by the United States Bureau of Reclamation at its Denver office, has resigned to accept a position with the J. G. White Engineering Corporation of New York on work on the Santiago dam at Aguas Calientes, Mexico. Mr. Draeger is a graduate of Cornell University, class of 1909, and before going to Denver was assistant city engineer at Schenectady, N. Y.

HARRY H. SHEPARD has resigned as general superintendent, at Scranton, Pa., of the Delaware, Lackawanna & Western R.R. to become vice-president and general manager of the Brooklyn Eastern District Terminal. Mr. Shepard was at one time assistant engineer on the New York, New Haven & Hartford; he also served in the operating departments of the Burlington, Cedar Rapids & Northern and other roads.

E. W. FASSETT, who recently completed a two-year term as city engineer of Casper, Wyo., has been appointed city manager of El Reno, Okla.

ARTHUR T. CLARK, superintendent of the Municipal Commission of Herkimer, N. Y., in charge of electric, water, police, fire and sewer departments, is now with the South Bay Consolidated Water Co. with headquarters at Bay Shore, Long Island. Mr. Clark is a graduate of Rensselaer Polytechnic Institute and has served in the bureau of hydraulics of the New York State Barge Canal; with Robert E. Horton, consulting hydraulic engineer, Albany; and as engineer for a new gravity water supply for Herkimer.

HARRY N. JENKS, for some years past superintendent of the pumping and filtration works at Sacramento, Calif., has joined the engineering faculty at Iowa State College, Ames, Iowa, as associate professor in charge of sanitary engineering subjects, formerly under the direction of Prof. C. S. Nichold who is now sanitary engineer for the city of Miami, Florida.

LINDON J. MURPHY has been appointed municipal engineer of the engineering extension department of Iowa State College, Ames, Iowa, succeeding R. S. Wallis. Mr. Murphy has been engaged in municipal engineering practice in Illinois and was formerly an instructor in civil engineering at Iowa State College.

R. S. WALLIS, until now municipal engineer of the engineering extension department at Iowa State College, has been appointed city manager at Manistique, Mich.

GEORGE L. KNOTT who was formerly with R. W. Hebard & Co., of Panama, is now division engineer with the Long Island State Park Commission at Mineola, L. I.

J. G. MACKINNON, assistant engineer with the T. Eaton Co., at Moncton, New Brunswick, since 1918, has accepted a position on the engineering staff of the International Paper Co., in connection with the power development at Grand Falls, N. B.

HORACE L. SEYMOUR, town planning consultant, Toronto, has joined the organization of Harland Bartholomew, of St. Louis, Mo., in the position of resident engineer for the Vancouver Town Planning Commission's project.

S. E. ROOT, formerly with the Canadian International Paper Co., on construction work at East Templeton, Quebec, is now construction engineer with William I. Bishop, Ltd., at Shawinigan Falls, engaged on the construction of the extension to the mill for the Belgo-Canadian Paper Co.

MAJOR RAYMOND F. FOWLER, Corps of Engineers, until recently instructor in the General Service School at Fort Leavenworth, has assumed duties as district engineer of the Providence, R. I. District succeeding Major ROGER G. POWELL who has been transferred to the engineer district at Cincinnati, Ohio.

Obituary

HENRY MCL. HARDING, consulting engineer, New York City, died suddenly of apoplexy Aug. 24, aged 75 years. Mr. Harding was a consultant on terminal work in New York City, and for many years he had been consulting engineer on port and rail terminals on waterways throughout the country. During the war he was a member of the U. S. Shipping Board's committee on ports and terminals. In earlier years he was a pioneer in promoting the development of street railways in some New England cities and in the Middle West. Mr. Harding was born in Bath, Maine, and graduated in engineering at Yale in 1875. He was the first president of the Society of Terminal Engineers.

CHARLES D. BROWN, civil engineer, Ogden, Utah, and for the past ten years an employee in the city engineering office at Ogden, died Aug. 24 aged 70 years.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Tractors Save $8,000 For County in Three Months

Road Maintenance by Farmer-Overseer Plan Abandoned for Patrolmen on Full Time Using Tractors

THE CHANGE from the farmer-overseer plan of maintaining the county roads to the full-time patrolman plan has resulted in a big saving for Buchanan County, Mo., for the first three months that the new system has been in effect, according to an account in the St. Joseph *News-Press* which was based on a report made to the county court by Orville A. Loomis, county highway engineer. The following information is from the news account:

The change was made March 1, when, instead of appointing 41 road overseers as had been done in the past, the county court employed 14 full-time patrolmen and two road overseers. In the past the overseers used their own teams to perform the work, while under the new plan the county court purchased a caterpillar tractor for each district in charge of a patrolman. Figures for the first quarter, ended June 1, showed total expenses for maintenance and grading of $12,201.47. For the first quarter of 1924 the total expense of the overseers, who also did the grading work, was $20,146.85, or a saving under the new plan of $7.945.38. The cost of the road overseers for the first quarter of 1925 was a little over $15.000, but these overseers did no grading work.

FIRST QUARTER EXPENSES

Salaries of 14 road patrolmen	$5,250.00
Salaries of 3 grader men	1,062.50
Grease and oil used in 14 tractors	487.25
Gasoline used in 14 tractors	1,408.11
Extra help	334.00
Repair expense	136.00
Tractor cost on 3-year basis	2,556.75
Interest on investment	154.00
Total	$11,388.72
Overseer Districts Nos. 15 and 16 still under old system	812.75
Total	$12,201.47

In figuring the cost under the new plan, allowance was made for interest on the approximately $30,000 invested in tractors, and for deterioration of the tractors. According to Mr. Loomis, there is no question as to the improved condition of the roads under the new plan.

Water Softening Patent Suit Decided

The final decision in the Canadian patent suit between George Borrowman, Chicago, and A. C. Spencer (assignor to the Permutit Co., New York) gives priority to Mr. Borrowman in the invention of water softening with greensand. It is reported that applications for a patent were made by both parties and the Canadian Patent Office declared a conflict. In 1923, the Exchequer Court gave judgment for Spencer, but in 1925 the Supreme Court reversed this judgment and gave a decision in favor of Borrowman. The Permutit Co. then appealed to the British Privy Council, at London, and on July 10, 1926, the Council dismissed the case in favor of Borrowman and taxed the costs to the Permutit Co.

Manufacturer Compiles Booklet to Aid Fast Repair Part Service

Designed to form the basis of a 75-min. repair part service on Rex mixers and pavers, the new instruction book and parts list for the 27-E size, known as Bulletin No. 142, of the Chain Belt Co., Milwaukee, contains a new system of coding and numbering. This system is believed to eliminate most possibilities of error in ordering repair parts. By certain combinations, six letters to the word, a code system is built up that will still convey the necessary information to fill an order even though only four of the letters are transmitted correctly. According to mathematical computation, the chance for an error to occur that would make the system inoperative is claimed to be approximately one-tenth of 1 per cent.

Another feature is that the parts numbers correspond with actual drawing, casting or piece numbers. Each unit of the machine is shown assembled and also completely disassembled in order to clearly illustrate each part. Instructions for unloading, erecting and operating the mixers are given in detail as are also instructions for ordering parts and for finding the parts in the book. In order to operate a fast and efficient repair part service, it is necessary that the orders received from the contractor be correct. The main function of the new booklet is to reduce the chances of error on the part of the contractor to a minimum.

Business Notes

H. C. BECKWITH, for 11 years general manager, Byers Machine Co., Ravenna, Ohio, has resigned and will relinquish his executive duties in December, to make his future home in California. Mr. Beckwith will retain an official connection with the company as vice-president and will continue to serve in an advisory capacity.

KIRK & BLUM MFG. CO., Cincinnati, Ohio, manufacturers of pneumatic dust collecting, ventilating and conveying systems, announces the doubling of its plant facilities through the purchase of an adjoining factory. In addition to manufacturing blower systems, the company operates a "contract manufacturing" department, which handles production of sheet metal parts for many manufacturers. Commercial truck bodies, wall safes, etc., are some of the products made. The increased floor space will enable the company to enlarge its contract manufacturing facilities.

CHAIN BELT CO., Milwaukee, Wis., has appointed George E. Coursey and E. E. Elsey as its special representatives in southern Ohio, southeastern Indiana, and eastern Kentucky. The firm of George E. Coursey is located in the Union Central Building, Cincinnati, Ohio.

READING IRON CO., Reading, Pa., has placed O. R. Lane, formerly of its St. Louis territory, in charge of its new office in Kansas City, Mo. Mr. Lane's address is Pioneer Trust Building.

New Developments

New Metal Lath and Floor Joist Units Perfected

A concrete floor and ceiling construction under the descriptive name of "Locktyle" has recently been developed by and is now being marketed by the Truscon Steel Co., Youngstown, Ohio. There are two units in the new Locktyle construction. The first is a lath furnished in rolls 100 ft. long and 2 ft. wide with the ribs running crosswise. Into these ribs, at the proper distance from each end, a prong is punched upward. As the lath is rolled out on the form the ribs and prongs are on the

upper side. The second unit of the construction is a ribbed steel form for the joist, known as "Floretyle." Flanges on this Floretyle hook into the prongs of the previously placed lath, providing a permanent bond between the unit of floor construction and that of ceiling construction.

A number of advantages are claimed for this type of integral floor and ceiling construction. In the first place, speed of erection is important, since no time is lost in making attachment of the ceiling lath to the floor forms. Accuracy in spacing is also important, since an absolutely straight concrete joist is assured. The arch and lath are so tied together that it is impossible to collapse the arch during the pouring of concrete. The ceiling lath, due to its

rolled form, is free from irregularities and remains true and flat, thus requiring a minimum of plaster. Finally, since the floor arch can be immediately placed as the lath is unrolled, the workmen on the job need not walk on the lath and bend it out of shape.

Diesel-Electric Hopper Dredge in Use at Chicago

Hopper dredges are used to a large extent by commercial sand companies for handling their said from point of supply to their docks and material yards. The Construction Materials Co., of Chicago placed in operation about the middle of May one of the first hopper dredges to be equipped completely with Diesel-electric equipment.

The main engine equipment was supplied by the Worthington Pump & Machinery Corp., New York, and consists of two 600-hp. six-cylinder, four-cycle air-injection Diesel oil engines. To each of these engines a G.E. 400-kw. d.c. main generator, and a 50-kw. auxiliary generator serving as an exciter and for auxiliary power, are connected. These Diesel-electric units are used to supply electrical energy to the two propelling motors and to the sand pump motor. Each propelling motor is rated at 500-hp. The two sand pumps have an 18-in. discharge and each is driven by a 400-hp. motor. An 8-in. centrifugal jetting pump, driven by a 125-hp. motor, one located on each side of the ship, is used for pumping water into the sand when discharging it so as to provide the proper flow. The Ward-Leonard system of generator field control is used in propelling the ship.

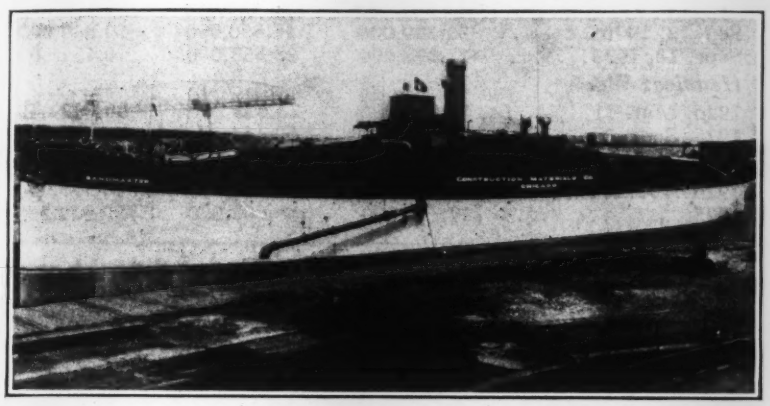


FIG. 1—DIESEL-ELECTRIC HOPPER DREDGE

This dredge is now in daily use loading sand from Lake Michigan 40 miles from Chicago and transporting it to the company's docks in Chicago and South Chicago where it is pumped from the dredge's hold.

The boat, which is 263 ft. long, 23½ ft. beam and 20 ft. molded depth, is a rebuilt ocean freighter that was turned out during the war. It has been in the process of conversion to Diesel-electric drive since late in 1924. It has a capacity of 3,000 tons of sand per hour and will operate on a pipe line of maximum length of 8,000 ft.

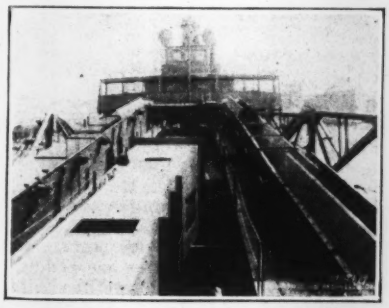


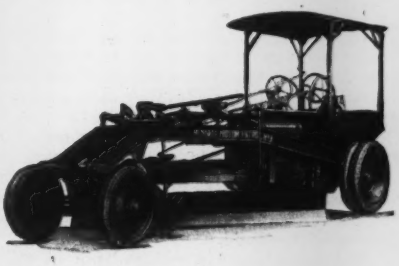
FIG. 2—HOPPERS OVER THE HOLD OF THE DIESEL-ELECTRIC DREDGE

Hoppers are located forward and aft directly above the hold. The fluid mixture of sand and water is pumped into the hoppers through two adjustable suction pipes, one on each side of the ship as shown in Fig. 1.

Motor Grader Incorporates New Features

The one-man motor grader recently developed by the Russell Grader Manufacturing Co., Minneapolis, Minn., features an independently adjustable scarifier and a maximum pressure of 4,200 lb. on the blade made possible by proper distribution of weight.

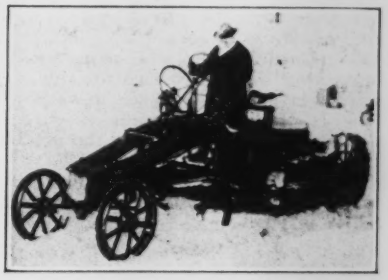
The grader has dual rubber-tired rear wheels and the front wheels are fitted with Timken bearings. The machine-cut gears are completely enclosed, bronze bushings and bronze collars are used on the worm shaft, a take-up bearing provided in the forward lifting arm bracket and a machined worm-gear steering control used. Alemite lubrication throughout is standard equipment.



The power plant is the 10-20 McCormick-Deering tractor with forward speeds of 2, 4 and 10 m.p.h. and reverse speeds of 3 and 8 m.p.h.

Patrol Grader Removes Ice Formed from Niagara Falls Spray

When the wind blows from the south it carries the spray from Niagara Falls over the main driveway of Queen Victoria Park, Ont., Canada. In the winter, this spray forms ice over the roadway to a depth of from 6 to 18 in. in one night. After trying several types of equipment which functioned unsuccessfully, the Wehr company, Milwaukee, Wis., states that one of its grader units with scarifier was used as shown in the picture. The 12-in. ice formation was completely broken up in 1 hr. ready for removal. The roadway was 36 ft. wide and 1,500 ft. long. Following use of the scarifier, the blade was next used and the section of ice cleared in less than 2 hr. It is estimated that a saving in time of two days was made and about $150 in labor cost.



Ditcher Attachment Permits Trench 4 In. Wide

The illustration shows a new machine recently built by Barber-Greene Co., Aurora, Ill., being used by the Outdoor Lighting Co., of Chicago, at Elmhurst, Ill. The machine is the same as the company's standard ditcher except that

it has a special vertical boom cutting 4 in. wide and 18 in. deep. The trench in this case was made for street lighting conduits. On this job the machine is said to have cut 1,000 ft. an hour several times and often 7,000 ft. a day.

New Publications

Suspension Bridge Cables — PAGE STEEL & WIRE CO., Bridgeport, Conn., and AMERICAN CABLE CO., New York, have issued jointly a 47-page booklet containing descriptive matter and numerous large photographic views of the 1,750-ft. Philadelphia-Camden suspension bridge, its erection and the making of the great 30-in. cables. The wire was manufactured by the former company, while the latter built up the cables in place.

Pipe Fitting Specialties — MUELLER STEAM SPECIALTY CO., INC., 502 West 126th St., New York City, devotes its catalog No. 122 to its many specialties for steam, water, air, oil, and gas. Pressure reducing and regulating valves, back pressure valves, release valves, pump governors, strainers, steam traps, air traps, and water feeders are some of the items illustrated, described and specified.

Draglines—GALION IRON WORKS & MFG. CO., Galion, Ohio, has issued a folder describing its dragline scraper for use with Fordson hoists or hoists of similar capacities. The folder also gives photographs of the other Fordson-operated road-building equipment of the company.

Concrete Waterproofing and Hardeners—THE MASTER BUILDERS CO., Cleveland, has issued two new specification books on concrete waterproofings and concrete hardeners. These have been compiled for use by architects, engineers and contractors, and have been thumb indexed for convenience. In the hardener folder, both integral and surface treatment, colored and uncolored, is specified. The waterproofing folder contains specifications on liquid, powder and paste waterproofing as integral compounds, and also specifies a number of types of damp-proofings and waterproofings for surface application.

Power Shovels—SPEEDER MACHINERY CORP., Fairfield, Iowa, in its latest bulletin J-26, describes its ½-yd. shovels, cranes and draglines. Clearance diagrams, tabulated specifications, illustrations and text make up the 12-p. folder.

Concrete Slab Construction—REPUBLIC FIREPROOFING CO., INC., 31 Union Square, N. Y., has issued a specification folder containing data and blueprints of its special slab construction for floors and roofs and also the results of tests made on this type of slab by the Columbia University Testing Laboratory. The construction consists of a hollow block known as Slagblok spaced about 20 in. apart on the forms and embedded between reinforced concrete ribs and beams.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Sept. 9, 1926	$15,567,000	$16,839,000	$32,406,000
Sept. 2, 1926	33,299,000	46,550,000	79,849,000
Sept. 10, 1925	17,898,000	28,553,000	46,451,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	788,140,000	1,226,237,000	2,014,377,000
1925	749,310,000	988,602,000	1,737,912,000

Prosperity—It Has Been Sustained in the Construction Industry

A Sound Industry Can Promptly Supply Increasing Demands Without Boosting Prices

PROSPERITY, according to press dispatches from White Pine Camp, is to be the Republican campaign issue this fall. Politics aside, few will question the fairly obvious fact that the construction industry is enjoying an unusually long and unusually flush period of prosperity.

If scientific proof of this fact were required one need merely turn to *Engineering News-Record* statistics, as presented in the Sept. 2 issue. On p. 398 the curves of construction cost and volume show that despite the heavy 1926 increase in demand for materials and labor the supply has been so adequate as to hold prices to a surprisingly even level. This means stability, which creates confidence, which assures prosperity.

A test of soundness in an industry is an ability to supply increasing demand without boosting costs. Unsoundness is immediately betrayed by a market that fluctuates with the demand—when prices rise sharply with active ordering and decline when orders fall off. Since 1922 the construction industry seems to have learned to curb the natural incentive to grab while the grabbing is good.

In April, 1925, the actual physical volume of construction as measured by the *Engineering News-Record* Construction Volume Index Number rose sharply to 211 from 161 for March (1913=100). This meant an increased demand for labor and materials of 31 per cent in the space of thirty days. This heavier demand has been consistently sustained until it may now be called the new plane of demand.

Did costs soar in recognition of this larger market? In March, 1925, the *Engineering News-Record* Cost Index stood at 210.20; it is now 208.30. Its range compared with the range of demand was as follows:

1925	E. N.-R. Cost Index	E. N.-R. Volume Index
March	210.20	161
April	209.55	211
May	207.20	209
June	204.60	214
July	204.60	178
August	204.60	266
September	202.10	262
October	205.35	233
November	205.95	194
December	205.95	206
1926		
January	207.15	198
February	206.55	187
March	207.65	240
April	207.05	233
May	207.30	254
June	204.80	246
July	207.80	248
August	208.30	252
September	208.30	248

The other charts in the Sept. 2 issue tell the same story of stability. In most instances the 1926 volume lines are well above those of 1925, while the 1926 price lines are under those of a year ago. Building construction, except residential, is heavier, as are road lettings also. Labor rates are generally higher, but prices are lower in the face of increased production. And the railroads have been prompt in handling all shipments.

Statistics of the construction industry do more than "show"—they establish the fact that there has been no break in the year's unparalleled activity. They do not speak for the future; but there seems to be no reason to expect a serious slackening. The country is in a mood to continue doing business on a large scale.

E. N.-R. Unit Prices on Recent Jobs

Remarkably Close Estimating on Pennsylvania Bridge

Bids were opened by Commissioners Allegheny County, Courthouse, Pittsburgh, July 14, for bridge masonry and approach filling for bridge over Monongahela River connecting McKeesport and Duquesne, from (A) Vang Construction Co., Bessemer Bldg., Pittsburgh, (awarded contract); (B) Dravo Contracting Co.; (C) Foundation Co. The unit bids are as follows:

	A	B	C
3,511 cu.yd. excavation in foundations above elevation 733.00	$6.00	$8.00	$4.50
1,446 cu.yd. excavation in foundations below elevation 733.00	15.00	8.00	24.50
132 cu.yd. concrete in foundations of pier No. 4 above elevation 733.00 except cylindrical caissons	14.60	12.00	11.50
84,400 cu.yd. concrete in foundations of piers Nos. 1, 2, and 3 below elevation 733.00	13.00	10.00	11.00
251 cu.yd. concrete in cylindrical caissons of pier No. 4	18.00	18.00	11.00
330 cu.yd. concrete in pedestals	20.00	18.00	15.00
357 cu.yd. plain concrete in foundations of abutments	20.00	16.00	12.50
4,037 cu.yd. concrete in Piers Nos. 1, 2, 3, and 4 above foundations including volume of sandstone	13.50	13.00	13.00
380 cu.yd. plain concrete above foundations in abutments	24.00	22.00	19.50
929 cu.yd. reinforced concrete in abutments	20.00	18.00	18.00
3,300 sq.ft. stone facing for piers	4.50	4.00	2.70
600 bbl. extra Portland cement	2.45	2.50	2.32
218 cu.yd. stone drains	5.50	6.00	11.50
460 sq.yd. membrane waterproofing	3.60	3.00	5.00
39,600 lb. structural steel	.10	.10	.07
92,200 lb. steel reinforcing and dowels	.06	.06	.05
6,700 lb. anchor bolts	.20	1.5	.12
435,000 lb. steel sheet piling left in place, as indicated on plans, upon written orders of the Director	.03	.06	.05
10 m.ft.b.m. timber sheeting left in place upon written order of Director	130.00	40.00	30.00
3,611 cu.yd. earth filling for approaches	1.30	1.00	1.00
7,945 cu.yd. slag filling for approaches	1.20	1.40	1.75
300 cu.yd. run-of-bank slag surfacing	1.20	4.00	5.50
5 m.ft.bm. lumber in temporary roadways, steps, footwalks, barriers, etc.	130.00	150.00	153.00
816 cu.yd. excavation (grading)	1.25	2.50	2.00
3,000 lin.ft. premolded reinforced concrete piles	2.00	3.00	3.00
Extended totals	$222,649	$225,526	$226,722

Concrete Road in Kansas

Bids were opened by State Highway Commission, Topeka, July 16, (lowest four and highest) for Federal Aid Project No. 268, Sect. "E," State Highway No. 92, Leavenworth County, (A) Reise & Shearer, Kansas City, (awarded contract); (B) F. P. Sargent Construction Co., Leavenworth; (C) Massman Construction Co., Kansas City, Mo.; (D) T. G. Morris & Co., Oskaloosa; (D) Hyman Spitkaufsky, Kansas City, Mo. The unit bids are as follows:

	A	B	C	D	E
90,086 cu.yd. earth excavation	$0.28	$0.27	$0.32	$0.30	$0.36
553 cu.yd. earth borrow	.28	.27	.32	.30	.36
550 cu.yd. rock excavation	2.00	1.50	1.50	2.00	2.50
651.4 cu.yd. class "A" concrete	18.00	21.00	19.00	21.00	21.00
2 cu.yd. class "E" concrete	40.00	40.00	35.00	40.00	35.00
57,722 lb. reinforcing steel in place	.05	.05	.05	.05	.05½
3,290 lin.ft. guard fence, cable, R.C. posts	.70	.90	.80	1.00	.80
41.2 stations hedge to be removed	5.00	10.00	10.00	10.00	15.00
Extended totals	$43,679	$45,316	$48,206	$48,639	$54,083

Outfall Sewer and Treatment Plant in Illinois

Bids were opened by Bd. Local Improvements, Mundelein, July 21, for constructing outfall sewer and treatment plant, from (A) O'Brien Bros., 1923 North Kildare St., Chicago (awarded contract); (B) Union Construction Co., Des Moines, Ia.; (C) G. Chapman; (D) H. Rees & Sons, Quincy; (E) S. J. Groves. The above bidders are those who bid for the complete job. The unit bids are as follows:

	A	B	C	D	E
11,450 lin.ft. 27-in. vitrified tile pipe sewer	$4.10	$5.00	$4.70	$6.00	$6.75
4,390 lin.ft. 21-in. vitrified tile pipe sewer	3.10	2.50	2.88	4.00	7.75
1,505 lin.ft. 18-in. vitrified tile pipe sewer	7.50	5.00	3.45	4.50	7.75
1,170 lin.ft. 10-in. vitrified tile pipe sewer	1.50	1.00	1.55	1.50	2.99
500 ft. of depth, concrete manholes	7.00	10.00	7.00	6.00	10.00
56 manhole frames and covers	14.00	10.00	12.50	12.00	12.00
1 settling tank by-pass chamber	100.00	100.00	125.00	178.00	225.00
1 filter bed by-pass chamber	100.00	100.00	125.00	156.00	225.00
1 two story settling tank	26,000.00	20,500.00	13,600.00	15,500.00	39,900.00
1 dosing tank	1,650.00	1,200.00	5,050.00	3,175.00	4,500.00
1 filter bed	25,840.00	32,000.00	38,400.00	35,950.00	42,000.00
1 settling tank	2,470.00	2,800.00	2,350.00	3,375.00	6,500.00
1 clarifier unit	4,400.00	4,000.00	5,000.00	4,750.00	6,.00.00
1 pump house	2,625.00	2,500.00	3,100.00	5,330.00	4,500.00
1 sludge bed	1,940.00	2,200.00	2,600.00	2,600.00	3,500.00
1 headwall	110.00	100.00	125.00	279.00	175.00
Extended totals	$143,115	$147,980	$148,139	$169,752	$240,169

Crude oil production in the United States in the week ended Sept. 4 totaled 2,196,300 bbl. per day, an increase of 19,450 over the average daily output of the previous week. The increase was in the fields east of California.

Federal Reserve Board's weekly condition statement of 697 reporting member banks as of Sept. 1 shows an increase of $110,000,000 in loans and discounts and a decrease of $16,000,000 investments.

On Concrete Piling

The following unit prices are included in the low bidders' estimates on various contracts awarded, 1923 to date:

Location	Date	Lin.Ft.	Price per Lin.Ft.
Viaduct, St. Louis, Mo.	June, 1923	35,170	$2.10
Bridge, Charleston, S. C.	Aug., 1923	47,120	2.89
Delaware River Bridge approach piers, Philadelphia, Pa.	Feb., 1924	3,000	2.00
Camden, N. J.	Feb., 1924	6,000	3.45
Viaduct, Jersey City, N. J.	Mar., 1926	6,150	2.50

Steel and Cement Shipments Indicate Construction Activity

The present activity in steel and cement movements constitutes a reliable indicator of the persistence of the construction drive, begun in 1922 and still making headway.

Shipment statistics are evidently more indicative of actual volume of work being done than either mill output figures or bookings of forward orders.

The seven-months total of structual steel shipments in 1926 was 8 per cent greater than for the corresponding period last year. Cement shipments, however, for the same period showed a gain of only 2 per cent, compared with the first seven months of 1925.

The per cent gain (+) or loss (—) each month this year over the corresponding month in 1925, in steel and cement shipments, follows:

	Steel Per Cent	Cement Per Cent
January	+ 17	+ 10
February	+ 3	— 3
March	+ 12	— 7
April	+ 5	— 10
May	+ 3	+ 7
June	+ 8	+ 9
July	+ 6	+ 3

The gains in steel shipments are conspicuous, compared with cement, which fell below 1925 in February, March and April of this year. Steel showed a greater increase than cement in every one of the seven months except May and June, 1926.

The following computations on fabricated structural steel shipments are by the Department of Commerce, the figures on cement were compiled by the Bureau of Mines, both are for the nation as a whole:

	Structural Steel Shipments Tons		Cement Shipments Barrels	
	1926	1925	1926	1925
Jan.	207,400	176,900	5,672,000	5,162,000
Feb.	192,150	186,050	5,820,000	6,015,000
March	250,100	222,650	9,539,000	10,279,000
April	244,000	231,800	12,961,000	14,394,000
May	237,900	231,800	17,951,000	16,735,000
June	253,150	234,850	19,113,000	17,501,000
July	265,350	250,100	18,767,000	18,131,000
7 mos.	1,650,050	1,534,150	89,823,000	88,217,000

Sales of six chain store systems in August and in the first eight months of 1926 show substantial increases over similar periods of 1925.

More cars were loaded with revenue freight in the week ended Aug. 28 than in any previous week. The total was 1,136,233 cars. This beat the former record, made in the corresponding week of August, 1925, by 11,795 cars.

Weekly Construction Market

The rate at which materials are actually being consumed in current construction operations, as compared with the corresponding period in other years, is indicated by statistics of revenue freight loadings furnished by the American Railway Association.

Since the two industries, construction and automotive, are considered largely responsible for present prosperity, car loadings in these are shown, compared with total freight movements.

The following tabulation shows revenue loadings, for the entire country, during the first thirty-two weeks of this year, 1925 and 1924:

First Thirty-two Weeks of	All Classes of Revenue Freight Cars	Construction Materials* Cars	Automobiles and Motor Trucks* Cars
1926	31,364,930	8,154,881	627,298
1925	30,326,099	7,884,785	606,521
1924	28,597,081	7,435,241	571,941

*Estimated by E. N-R.

Mere figures on total number of freight cars moved during the period in question, would mean little were it not for the fact that the average load per car is now a fraction of a ton greater than at this time in the other two years.

The element of distance is also important in the consideration of freight movements. With this in mind it is found that freight traffic, measured by the number of tons of freight to each mile of the distance covered, amounted to 227,116,889,000 net ton-miles, for the first half of 1926, exceeding by 0.7 per cent the best previous record, which was made during the corresponding period in 1923.

The volume of freight handled was heaviest in the Southern district, with the Eastern next and the Western third, comparing the first six months of 1926 with the same period last year.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	—$3.75
Structural rivets, 100 lb	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	51%	53.6%	51%	54.25%	36%	35.6@49.2%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	52.60@53.60	45.25	54.00	49.20@50.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	62.00	34.00	56.00	40.50	38.25	34.75	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	075	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.075	076	075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, gal	.95¼	.99¾	1.13	+.92	—1.03	1.14	+1.04	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅜	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.60	.40@.45	.50	50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅜c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Sept. 2 the next on Oct. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, Lcl.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.156). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Business Briefs

Call money quoted at 4½ per cent, Sept. 7; year ago 4 per cent.

Time loans: Sixty-ninety days, 4¾; four-six months, 4¾@5 per cent.

Commercial paper: Best names 4¼ per cent; other names, 4½ per cent.

On Sept. 1, 1926

E. N.-R. Construction Cost Index Number 208.30

E. N.-R. Construction Volume Index Number 248

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month